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АКАДЕМИЯ НАУК СССР

АКАДЕМИК
Н. И. ВАВИЛОВ

МИРОВЫЕ РЕСУРСЫ
СОРТОВ ХЛЕБНЫХ ЗЛАКОВ,
ЗЕРНОВЫХ БОБОВЫХ, ЛЬНА
И ИХ ИСПОЛЬЗОВАНИЕ
В СЕЛЕКЦИИ

ИЗДАТЕЛЬСТВО АКАДЕМИИ НАУК СССР
МОСКВА-ЛЕНИНГРАД

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ACADEMY OF SCIENCES OF THE USSR

Academician
N.I. VAVILOV

WORLD RESOURCES OF CEREALS,
LEGUMINOUS SEED CROPS AND FLAX,
AND THEIR UTILIZATION IN
PLANT BREEDING

Published by
The Academy of Sciences of the USSR
Moscow, 1957

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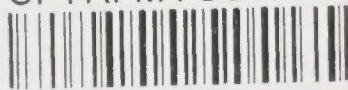
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Н. И. ВАВИЛОВ

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AGROECOLOGICAL SURVEY
OF THE
MAIN FIELD CROPS

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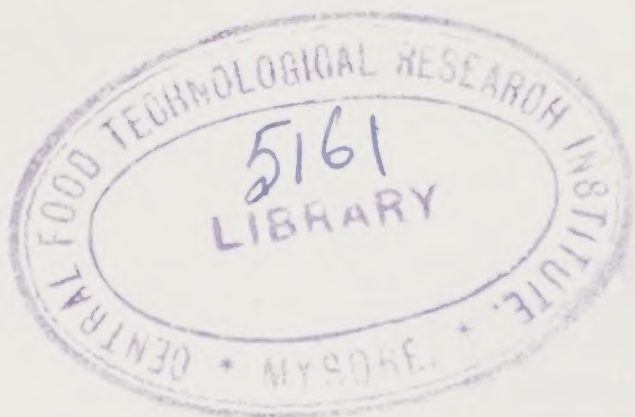
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CONTENTS

Editors' foreword	1
Introduction	7
 Chapter I. PRINCIPLES OF AGROECOLOGICAL CLASSIFICATION OF CULTIVATED PLANTS	21
Main properties taken as a basis for agroecological classification of cultivated plants	28
Growing period as related to climatic conditions	28
Rate of development	32
Rate of grain filling during maturation	33
Response to heat and cold	33
Winter hardiness	33
Response to soil and atmospheric drought	37
Edaphic (Soil) differences	38
Germination of seeds in plants not yet reaped; duration of post-harvest maturation	41
Infectious diseases and insect damages	42
Agronomic conditions	45
Land fertilization	48
Evolution of harvesting methods	51
Trends of selection	54
Industrial requirements for plant raw materials	67
Variability of characters	71
Range and distribution of agroecological groups	72
 List of the main characters and properties considered in the elaboration of an agroecological classification adapted to annual cereals, leguminous seed crops, and flax	76
Habit of plant	76
Growing period	76
Other biological and physiological properties	76
Immunity to infectious diseases and resistance to insect injuries	76
Technological properties	76
 Chapter II. MODERN GEOGRAPHY OF CEREALS, LEGUMINOUS SEED-CROPS AND FLAX	77
List of the agroecological districts and regions of the world (adapted to cultivated plants of the temperate zone)	86
Hither Asia (southwestern Asia in the broad geographical sense)	86
Caucasus (in a broad geographical sense)	86
Central Asia (in a broad geographical sense)	86
India and Pakistan	87
Arabia	87
Ethiopia and Eritrea	87
Mediterranean countries	87
Eastern Asia (in a broad geographical sense)	87
Southern Europe (in a broad geographical sense)	87
Mountain areas of western and central Europe	88
Northwestern Europe (in a broad geographical sense)	88

The European steppe agroecological region (in a broad geographical sense)	88
Eastern European forest-steppe agroecological region (in a broad geographical sense)	88
Eastern Europe forest region (in a broad geographical sense)	88
Siberia	89
North America	89
South America	89
Australia and New Zealand	89
South Africa	89
 Chapter III. AGROECOLOGICAL REGIONS OF ASIA, EUROPE, AND NORTH AND EAST AFRICA (applying to cereals, leguminous seed crops, and flax)	 90
Hither Asia	90
1. Syro-Palestinian inner mountainous and arid region	93
2. Asia Minor inner mountainous region	99
3. Pontic humid subtropical region of Asia Minor	105
Caucasus (in a broad geographical sense)	111
4. Moist mountain regions of western Georgia	121
5. Mountain steppe comparatively dry regions of Georgia and Azerbaijan 450-1,500 m above sea-level	124
6. High mountain (over 1,500 meters above sea-level) sufficiently humid steppe areas of Armenia, Georgia, and Daghestan	127
7. Moist region of Zakataly	129
8. Dry Armenian highlands	130
9. Karabakh mountain region	132
10. Nakhichevan irrigation regions (near Arax River)	132
11. Caspian insufficiently moist region (foothill and lowland regions of eastern Daghestan and Azerbaijan)	135
12. Apsheron semi-desert region	136
13. Talysh moist subtropical agroecological region (including Lenkoran and Astra regions as well as the Astrabad, Mazanderan and Ghilan provinces of northern Iran)	136
14. Zuvand mountain region (near Iran)	138
15. Foothill and mountain moist regions of northern Caucasus	140
Central Asia (in a broad geographical sense)	141
16. Iran-Turkestan agroecological region	141
16a. Foothill and mountain regions of drylands with a sufficient water supply	142
16b. Foothill and mountain regions of drylands with an insufficient water supply	147
16c. Foothill and mountain regions of irrigated crops	150
16d. Khiva oasis	157
16e. Oases of western China (Sinkiang)	159
17. Agroecological region near the city of Kabul	163
18. High-mountain Central-Asiatic agroecological region	164
18a. High-mountain regions of Hindu-Kush and of the Hissar, Turkestan, Alai and Transalai mountain ranges	166
18b. Pamir-Badakhshan high-mountain agricultural regions	167
18c. High-mountain agricultural regions of the Himalaya	167
18d. Agricultural Tibetan oases	169
19. Agricultural regions of northwestern Tian-Shan (foothill and mountain regions of Kirghizia and Kazakhstan)	169

India and Pakistan	172
20. Southern slopes of western Himalayas, including Kashmir and elevated regions of the northwest	173
21. Northwestern arid low-lying areas of India, including Punjab, the North West Frontier Province together with Peshawar, Sind, and the western part of Rajasthan	175
22. Central India	176
23. The Baluchistan mountainous agricultural region	180
Arabia	182
24. Mountain Arabian agroecological region (Yemen)	182
Ethiopia and Eritrea	182
25. Ethiopia agroecological region (including high-mountain regions of Ethiopia and Eritrea)	182
The Mediterranean countries	196
26. True Mediterranean agroecological region	196
27. Mountain regions of north Africa (Atlas mountains, Kabylia, Rif mountains in Morocco)	201
28. Mountain regions of Cyprus and Crete	207
29. Egyptian agroecological region, including the regions of Upper and Lower Egypt and Sudan	215
30. Aegean agroecological region	218
31. Inland oases of Syria, Morocco, and Algeria	224
Eastern Asia (in a broad geographical sense)	224
32. Chinese Japanese agroecological region (in a broad geographical sense)	224
32a. Regions of northern China	229
32b. Regions of central China	230
32c. The Great Chinese Plain	230
32d. The Red Basin	232
32e. Yunnan plateau	232
32f. Regions of southeastern China	232
32g. Agricultural regions of Korea	232
32h. Agricultural regions of Japan	234
33. Mongolian agroecological region	237
34. Northeastern China agroecological region	242
34a. Heilungkiang and Kirin	246
34b. Southern part of northeastern China	246
Southern Europe (in a broad geographical sense)	247
35. Agricultural regions of inland Spain	248
36. Portugese agroecological region	248
37. Agricultural regions of southeastern France	252
38. Agricultural regions of inland Italy	252
39. Agricultural regions of northeastern Greece and Macedonia	255
40. Balkan mountains agroecological region	257
Mountain districts of West and Central Europe	257
41. Pyrenean agroecological region	259
42. Alpine-Tyrolian agroecological region	260
43. Carpathian agroecological region	260
44. Mountain (upper) Germany	260
45. Czechoslovakian agroecological region	262

Northwest European region (in a broad geographical sense)	264
46. Northwestern French lowland agroecological region, including Belgium	268
47. Northern lowland German agroecological region	270
48. Baltic agroecological region, including northern Poland, Kaliningrad District of the RSFSR Lithuania, Latvia, Estonia, and southern central part of Finland	274
49. Maritime west European agroecological region, including lowland Great Britain and Ireland, Holland, Denmark, southern coastal Sweden, narrow strip of southern coastal lowland Norway	274
50. Scandinavian agroecological region, including regions of inland Sweden, Norway and Finland	276
European steppe agroecological region (in a broad sense)	283
51. Hungarian steppe, including its surrounding foothill regions, among them Banat	284
52. Danubian Steppe, including lowland Rumania and northern Bulgaria (the Great Walachian Plain)	284
53. Steppe Ukraine, including Moldavia and the steppe Crimea	286
54. The northern Caucasus steppe	291
55. The Volga steppe	291
The forest-steppe agroecological region of east Europe (in the broad geographical sense)	295
56. Western forest-steppe region	295
57. Eastern forest steppe region of European part of the USSR	296
Forest region of eastern Europe (in the broad geographical sense)	302
58. Forest region of Poland	302
59. Western non-chernozem region of European part of the USSR	304
60. Eastern non-chernozem region of the European part of the USSR	308
Siberia	311
61. West-Siberian steppe region	311
62. West Siberian forest steppe region	312
63. West Siberian Taiga region	316
64. Altai and Sayan agricultural region	316
65. The eastern Siberian agroecological region	318
66. The Trans-Baikal Buryat Mongolian agroecological region	321
67. Yakutsk agroecological region	322
68. Amur agroecological region	322
69. Far Eastern maritime agroecological region	325
70. Arctic Eurasian agroecological region	327
Chapter IV. AGROECOLOGICAL REGIONS OF NORTH AMERICA, AUSTRALIA AND SOUTHERN FRANCE	331
North America	331
71. Western Canadian forest agroecological region	332

72.	Eastern Canadian forest agroecological region (Quebec Province)	333
73.	The agricultural regions of Alaska	335
74.	Forest steppe agroecological region of Canada	335
75.	Central steppe agroecological region of Canada and the USA	341
76.	Southeastern steppe agroecological region of the USA	341
77.	Illinois agroecological region	343
78.	Great Lakes agroecological region of the USA	343
79.	Western highland region of the USA (Great Basin)	344
80.	Northwestern coastal agroecological region of the USA	344
81.	Southwestern highland agroecological region of the USA	348
82.	Southeasten lowland agroecological region of the USA	348
83.	Mexican highland agroecological region	348
South America		354
84.	Areas of the Argentinian pampas including Uruguay	360
85.	Western and southern periphery of the Argentinian pampas	370
86.	Brazil—Southern steppe region	370
87.	Irrigated areas of Chile	372
88.	High mountains of Peru and Bolivia	376
Australia and New Zealand		380
89.	Southern coastal region of Australia, including Tasmania	389
90.	Southeastern steppe region of Australia	390
91.	Dry regions of southwestern Australia	390
92.	New Zealand agroecological region	390
South Africa		396
93.	Coastal South African agroecological region	399
94.	Southwestern part of Cape Province	399
95.	South African agroecological region	400
Index of personal names		401
Index of common plant names		404
Index of Latin plant names		408
Index of geographical names		411
List of illustrations		431

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX
EDITORS' FOREWORD

5 The Presidium of the Academy of Sciences of the USSR has taken the decision to bring out the works of Academician Nikolaï Ivanovich Vavilov, prominent Soviet geneticist, botanist, plant-breeder and geographer. N.I. Vavilov was the first President of the V. I. Lenin All-Union Academy of Agricultural Sciences and Head of the All-Union Institute of Plant Breeding in Leningrad and the Genetics Institute of the Academy of Sciences of the USSR in Moscow. As President of the Geographical Society of the USSR, he organized a large number of expeditions to Asia, Europe, Africa and America, and in 1926, became one of the first scientists to be awarded the V.I. Lenin prize.

In the extremely rich scientific legacy left us by Nikolaï Ivanovich Vavilov at his untimely death were a number of unpublished manuscripts. These included the work written by Nikolaï Ivanovich in 1940, "World Resources of Indigenous and Selected Types of Cereals, Leguminous Seed Plants and Flax and their Utilization for Purposes of Selection". This work was meant to comprise a number of volumes, and the author gave it the following subtitle: "An Attempt at Establishing an Agroecological Classification of the Various World Varieties of Wheat, Rye, Oats, Barley, Peas, Lentils, Grass Peas, Chick Peas, Beans, and Flax with Reference to the Requirements of Plant Breeding."

Simultaneously with this book, the "Selected Works" of N.I. Vavilov in five volumes are being prepared for the press.

The present book constituted the introductory part of the work conceived by N.I. Vavilov which was to summarize more than twenty years of research on cultivated plants. N.I. Vavilov intended the introductory part to make up the first volume; he proposed to devote the second volume to wheat, the third to rye, barley, and oats, the fourth to leguminous seed crops, and the fifth to flax. However, he did not succeed in fully realizing this intention.

In addition to the first volume now published, there remained the second volume, not entirely completed, dealing with the origin and evolution of wheat. It presents an extensive description of all agroecological groups of wheat, taking into account the various types in existence throughout the world.

The Editorial Board hopes that it will soon be able to prepare the second volume also for the press.

The study of world agricultural resources (including selected types) of crops of Euro-Asiatic origin was based on extensive observations carried out by N.I. Vavilov in the course of his numerous expeditions and of many years of research in experimental stations which he pursued with the aid of a team of scientific workers of the All-Union Institute of Plant Breeding, of the V. I. Lenin All-Union Academy of Agricultural Sciences, and of the Genetics Institute of the USSR Academy of Sciences.

6 The basis of this work was provided by the results of the study of a world collection of cultivated plants accumulated by N. I. Vavilov in the course of many expeditions in the USSR and in foreign countries, as well as some collected on his initiative by a number of co-workers at the institute which he headed. N.I. Vavilov repeatedly explored the Caucasus, the mountain areas of Central Asia, the Far East, the western regions of the Ukraine and many other territories of our homeland, including the central chernozem (black soil) regions, the chernozem steppes of the Ukraine and the Kuban, the Volga regions, etc.

N.I. Vavilov organized his first expedition to Iran and the Pamirs as far back as 1916. In 1924, he conducted an expedition in Afghanistan, and in 1925 in Khorezm; in 1926-27 he visited all the Mediterranean countries, including the islands of Sardinia, Sicily, Cyprus and Crete, and also Ethiopia and Eritrea; in 1929 he toured West China (Sinkiang), the island of Taiwan, Korea and Japan; in 1930 he visited Central America and Mexico; in 1932-33, he went to Cuba, the Yucatan, Peru, Bolivia, Chile, Brazil, Argentina, Uruguay, Trinidad and Puerto Rico. In addition, he studied in detail the vegetable resources of the USA, Canada, Germany, France, Holland, Denmark and Sweden. Large scale expeditions were also carried out in other countries where agriculture has been practiced since ancient times. These were part of the general plan of work of the All-Union Institute of Plant Breeding, conceived on the initiative of N.I. Vavilov, with the aim of collecting plant resources. Among these expeditions were those of P.M. Zhukovskii to Asia Minor, northern Mesopotamia, and the island of Rhodes, and that of S.M. Bukasov and S.V. Yuzepchuk to Mexico, Colombia and other countries of Latin America.

All the material collected during the expeditions and by means of exchanges — more than fifty thousand samples of wheat, rye, barley, oats, peas, lentils, grasspeas, beans, chickpeas — was thoroughly studied by sowing over a number of years in the Experimental Station of the Institute of Plant Breeding and in the various bases of the USSR Academy of Sciences in different areas of our great country.

In addition, N.I. Vavilov organized special experiments of "geographical transplantation" of equivalent sets of species from world-wide collections under the different natural and man-made conditions of our country.

In the first of the above series, experiments were carried out at more than a hundred points; in the second series, nearly forty points were involved.

On N.I. Vavilov's initiative, extensive periodic interbreeding of geographically close or remote forms of cereals, leguminous seed plants and flax was performed both under field conditions and in greenhouses.

All the samples of these collections were examined and many of them described in detail by Nikolai Ivanovich himself.

A large part of the material describing the collections was dictated by N.I. Vavilov in the fields and greenhouses in the towns of Pushkin, Derbent (Daghestan ASSR), in Otrada-Kubanskaya (North Caucasus) and in Moscow during the period 1933-1940. This material was deposited in the archives of the USSR Academy of Sciences in Leningrad. It contained a description of the collections of hybrids of periodic interbreeding and detailed evaluations of the susceptibility of the different varieties and types of the crops studied to fungus diseases and to parasites.

The collections were studied with the aid of all the modern methods of physiology, genetics, cytology, immunity and biochemistry.

The large fund of knowledge accumulated by N.I. Vavilov in the area of cultivated plants as a result of expeditions and agricultural station research enabled him to throw light on the question of the origin of a number of cultivated plants and to trace the historical development of individual agricultures in all the continents of the world.

Thus, N.I. Vavilov arrived logically at the conclusion that it was essential to elaborate an agroecological classification of cultivated plants and to distinguish species not only according to morphological features, but also according to a complex of biological and physiological properties most intimately connected with the

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX
environmental conditions, which are of special interest to the selector.

We may see the importance attached by N.I. Vavilov to this work from directions on the drawing up of an ecological map of the USSR written by him on May 26, 1940. Here are some extracts from these instructions: "The correct geographical distribution of the various species and varieties of cultivated plants is of ever-growing significance in the planned state economy of our country.

"The more than 140 million hectares devoted annually to cultivated plants demand a planned distribution, which should be based on a knowledge of the individual properties of the variety.

"Hence the significance of ecology as a science or theory on the interrelationships between vegetable and animal organisms and the environment.

"Organisms are inseparable from their environment. The environment impresses its peculiarities on the appearance of vegetable and animal organisms. Thus, a definite ecological appearance of varieties, crops and species is elaborated. When transplanting individual species and varieties from certain areas to others, certain countries to others, we must take into account their ecological appearance, and thus make a correct choice of the suitable participants in the transplanting. This is the basis of correct acclimatization of crops, of the correct use of varieties, and of correct geographical distribution.

"The extensive acclimatization activities of the All-Union Institute of Plant Breeding", as N.I. Vavilov indicated later on in the same directions, "has led to a mobilization of the species and varieties, the resources of cultivated plants, with the aim of introducing their growth in the most suitable areas and of using them by means of interbreeding and of amelioration of our existing varieties, by taking into consideration various valuable individual properties of these or other ecological types, or, to put it briefly, of the ecotypes."

"Thus, we arrived logically at an ecological classification of cultivated plants and a differentiation of the species not only according to the usual morphological features, but also according to a complex of properties, which to a considerable extent includes the physiological and biological characteristics most intimately connected with the conditions of the environment."

Data on the ecological classification of certain plants were published in fragmentary form in the volumes of "The Cultivated Flora of the USSR", published up to 1940. This publication was the first attempt at a critical review of the multitude of varieties of the most important world crops.

Data on the agroecological classification of cultivated plants were published in condensed form by N.I. Vavilov in 1940 in English under the title: "New Systematics of Cultivated Plants" in the book: "New Systematics", J. Huxley (editor), Clarendon Press, Oxford.

The above work contained a description of 95 "agroecological regions" based on climatic, soil and (in the broad sense of the word) geographical conditions, affecting the chief type resources of wheat, rye, oats, barley, peas, lentils, chief peas, grass peas, beans, and flax.

By the term "agroecological regions" N.I. Vavilov meant a large territory usually equivalent to several administrative regions; by "agroecological areas" he meant smaller territories which were nevertheless quite often distinguished by contrasting climatic, soil and ecological conditions and, correspondingly, ecotypes.

The agroecological description of the various regions was drawn up on the basis of the author's personal knowledge of a number of them and on extensive study of the literature in strict conformity with the meteorological data.

Not all areas of the world were treated with the same degree of detail in this book. The agroecological areas of the Trans-Caucasus, which N.I. Vavilov had himself visited a number of times, were the ones most fully studied. He gave but a short description of India and China, apart from western China (the province of Sinkiang), since at that time there was not sufficient available material. Despite repeated attempts and his strong desire to travel to India and Southeast China, he did not succeed in doing this. Nevertheless, N.I. Vavilov often pointed to the great importance of these areas, which are characterized by a very ancient agriculture.

Simultaneously with the study of the agroecological groups of world resources of indigenous and selected varieties of cereals, leguminous seed plants and flax, N.I. Vavilov was occupied with broader research directly connected with the origin of cultivated plants and their habitat in the contemporary agricultural countries of the world, i.e., with the history of agricultural cultivation.

He had also collected, for the purpose of this work, a very large quantity of material on the evolution of agricultural implements, the basic means of production of cultivated plants, as well as material concerning land tenure, the history of ameliorative projects — irrigation and land drainage — the dynamics of the development of sown areas, and finally the overall yields of individual cultures.

N.I. Vavilov was in Kiev in July 1940 and reached an agreement with the Academy of Sciences of the Ukrainian SSR to hold in Kiev in September of that year a special All-Union Conference on the history of agricultural crops on the continent of Europe.

We took part of this material into account when writing the present book.

Despite the fact that more than sixteen years have elapsed since N.I. Vavilov wrote this book, to this day it possesses great scientific and commercial value.

The information contained in the book is entirely original and will be of considerable interest to botanists, geographers, plant breeders, and agricultural specialists having a broad scientific education.

We must note that during the period elapsing since 1940 many works have appeared in the field of plant geography, as well as in that of the systematics and origin of individual cultivated plants, in particular wheat (L.L. Dekaprelevich, 1941-42; P.M. Zhukovskii, 1950; V.L. Menabde, 1940-46; E.N. Makushina, 1948; M.M. Yakubtsiner, 1948, 1956; and E.N. Sinskaya, 1955), barley (F.Kh. Bakhteev, 1948, 1953, 1956) and others. Nevertheless, the general principles enunciated by N.I. Vavilov have not lost their importance. It is, of course, quite understandable that big changes have taken place in 16 years in the localization of agricultural crops in the different areas of the USSR and that the composition of varieties and standards has changed in foreign countries; but all these phenomena are perfectly natural and accord completely with N.I. Vavilov's opinions on the evolution of crops and varieties and the necessity of a planned replacement of existing varieties by new ones assuring larger yields on the basis of a broadly developed selection program.

Insofar as N.I. Vavilov's work has been published posthumously, the contents of the manuscripts have remained essentially without changes, and this includes his statistical data; all the minor changes introduced, as well as the additions, are indicated by editors' notes. Geographical names and administrative-territorial divisions are given by their present names (with the exception of Palestine and

Transjordan). The following reference publications were used when bringing geographical place-names up to date: "Administrative-territorial Division of the Union Republics", the Atlas of the World and special publications of the Geografiz (State Geographical Publishing House).

Professor I. F. Makarov, working on an assignment given by N. I. Vavilov, began a compilation of a few maps as far back as 1937. The drafts of certain maps were completed and used before the present work appeared. In this respect, the Editorial Board was far from being able to fulfil in its entirety the plan conceived by the author himself, who wished to provide the first volume of his work with more than 30 very accurate agricultural maps, as well as with an ecological map of the USSR, from the point of view of grain crops of the temperate zone. However, it was possible to compile only nine maps from the extant material.

The maps were drawn up in the Cartographic Bureau of the Geobotany Department of the V. L. Komarov Botanical Institute of the Academy of Sciences of the USSR. They were compiled by the cartographers A. A. Gerbikh and A. N. Shabliovskaya.

The book is illustrated by original photos, most of which were taken by N. I. Vavilov himself during his expeditions.

Pictures of the different crops were selected by specialists of the All-Union Institute of Plant Breeding: A. I. Mordvinkina (for oats), V. F. Antropova (for rye), E. V. Elladi (for flax). Most of the pictures were drawn by artists of the Institute: M. P. Lobanova, A. M. Shepeleva, M. G. Koente, N. Z. Semenova-Tyan-Shanskaya and others, and were examined by N. I. Vavilov himself.

The wheat photographs were made from original material consisting of spikes of wheat, presented by M. M. Yakubtsiner and L. L. Dekaprelevis.

For greater convenience, the book has been provided with a number of indexes (compiled by D. V. Lebedev): names, Russian and Latin appellations for plants, geographical names, tables of pictures, maps and photographs. The latter are located in the text in the same geographical order which the author adopted when describing agroecological regions. With the aim of providing a more uniform distribution of the photographic material, in conformity with the spirit of the manuscript, a part of this material was assigned to illustrate the introductory chapters.

The text of the manuscript of the first volume was examined and entirely approved in 1946 by Academician L. S. Berg.

During N. I. Vavilov's lifetime and thereafter, O. K. Fortunatova (now deceased) participated enthusiastically in the compilation of the meteorological tables.

In addition to the editorial board, many other persons took part in preparing N. I. Vavilov's manuscript for the press, among whom we must specially note Doctor of Biological Sciences E. I. Barulina-Vavilova, who preserved the manuscript and albums and also carried out a great deal of work in preparing the manuscript for printing, and Doctor of Biological Sciences Prof. M. A. Rozanova, who was of great assistance in editing the manuscript.



6 N.I. Vavilov, Portrait by the artist Streblou

The work of plant selection takes place in three basic stages: 1) mobilization and exploitation of local plant populations and those of other areas, as well as selected types, as initial material; 2) the application of individual, mass, group or family selection; and 3) the synthesis of new varieties by means of cross-breeding.

The history of plant breeding throughout the world shows that the successful use of valuable initial material quite often led to its adoption for large scale cultivation, both as selective material and even for the local community. Thus, for example, the most common variety of winter wheat (Triticum vulgare Vill.) in the USA, known under the name of "Turkey" and lately occupying up to ten million hectares, or nearly one-third of the entire tilled area under wheat in that country, represents an ancient type of local Crimean wheat--"Krymka", which was imported a few decades ago into the USA from Crimea.

The successes achieved by modern cotton-growing on a world scale are associated with the extensive use on all continents of what was originally "Mexican Uplands" cotton (Gossypium hirsutum L.) and Central American long-fiber cotton (Gossypium barbadense L.). The ancient grades of Asiatic Indian cotton (Gossypium herbaceum L.) were replaced in Central Asia by the American Uplands. The excellent Upland variety, the Acala, discovered by Cook in the villages of Southern Mexico, was the initial population for the creation of a multitude of selection types, both in the USA and in the USSR (the so-called Nos 8000), by means of individual selection. The Swedish races of oats (Avena sativa L.), "Victory" and "Golden Rain", raised in 1903 and 1908 by the Svalefskaya Station using the method of individual selection, have been widely propagated throughout the world. American standard types of corn (Zea mays L.), the result of a longer or shorter period of selection, have become common in our country. These include, among others, Minnesota 13, Minnesota 23, Brown County, Sterling and Leaming.

The decisive factor in the use of direct selection, and even more in the breeding of varieties by means of hybridization, is the correct choice of the starting material, that is, the correct selection of the components for cross-breeding. The results of selection are determined to a considerable extent by the composition of the arboretum of initial material.

In a number of crops, modern selection has arrived at a third stage of development -- the creation of types by means of cross-breeding.

Quite often, samples of the crops in question from the most varied countries have taken part in the formation of the best new hybrid varieties of wheat, barley (Hordeum sativum Jessen) and oats. This is clearly revealed by the genealogy of these varieties. Ancient indigenous species of India, China and Japan played the role of parents, together with European types, and took part in the creation of the contemporary standard strains of Canadian, Argentinian, Australian and Italian wheats. The successes of selection on a global scale have been determined to a considerable extent by the international character of the process.

Thus, wide geographical perspectives are essential in the selection of the initial material. In addition to the maximum use of valuable domestic flora, planned exploitation is needed, both of the native varieties of other countries and of types from the chief ancient regions of origin of cultivated plants. In addition, we must carefully weigh the results of former selection, from the oldest to the newest.

For 20 years (1920-1940) the All-Union Institute of Plant Breeding has carried out large-scale collective work in the planned utilization by Soviet

selectionists of an immense amount of material containing many varieties of the most important crops — to all intents and purposes from all the agricultural areas of the world. Exceptional resources of varieties have accumulated uninterruptedly as a result of the large number of expeditions carried out by the Institute in the Soviet Union and abroad.

In gathering our original material we were guided entirely by the theory of evolution. We followed the development of individual plants from their places of origin and their entrance into the stage of cultivation right up to the latest stages of the most recent European, American, Australian and Argentinian selection work. Extensive collections of grain and industrial crops were carried out in Iran, Afghanistan, India, China, Asia Minor, all Mediterranean countries, Ethiopia, and the mountain areas of Eritrea. Within the borders of our own country, a great deal of attention was paid to the study of local varieties in the Caucasus and Central Asia, the mountainous areas of which are exceptionally rich in endemic species and ancient native varieties. A large amount of material of local types was assembled in all the agricultural areas of the Soviet Union. The domestic and selected varieties of nearly all countries of Western Europe, as well as a selected assortment from the USA, Canada, Argentina, Chile, Australia and South Africa, were thoroughly explored.

All variety specimens accumulated by the All-Union Institute of Plant Breeding were sown over a number of years in various stations, some of them belonging to the Institute itself and others to other experimental research institutions — from the sub-Polar Station VIR (All-Union Institute of Plant Breeding 67° 44' North latitude) on the Kolya peninsula, to Tashkent, Sukhumi and the Far East inclusively.

The variety material from the Northern Caucasus was studied in special detail: in Otrada-Kubanskaya in the Krasnodar territory; in the vicinity of the town Stavropol in the Western experimental field; then, near Derbent in Daghestan; in Novocherkassk-on-the-Don near Kharkov in the Ukraine; in the Kamen Steppe in the Voronezh region; in Krasnyĭ Kut in the Saratov region; in Tarnau near Tashkent (in Central Asia) and also in the vicinity of Moscow and Leningrad. All of the variety collections accumulated by different expeditions and through exchange with various research institutions was first of all subjected to botanical treatment and introduced into an agrobotanical system. The results of this research were published by the All-Union Institute of Plant Breeding in the form of a voluminous book entitled "Cultivated Flora of the USSR"*. This book gives, for the first time, a complete botanical-agronomical survey of the world range of cultivated plants having economic value for the USSR.

The thorough study under different conditions of many thousands of samples with regard to their morphological and physiological properties elucidated their selection value for different areas and brought to light a large number of new varieties and forms which were unknown to previous selectionists.

* "Cultivated Flora of the USSR", State Agricultural Publishing House, Moscow - Leningrad, 1935-1950. The following volumes were published in 1935-1940: 1 - Wheat; 2 - Rye; 3 - Barley and Oats; 4 - Leguminous Seed Crops; 5 - Fibrous Plants, Part 1; 16 - Berries; 17 - Nuts. After 1940, the following volumes were published: 7 - Olives (1941); 8 - Perennial Leguminous Grasses; (1950).
[Editor's Note].



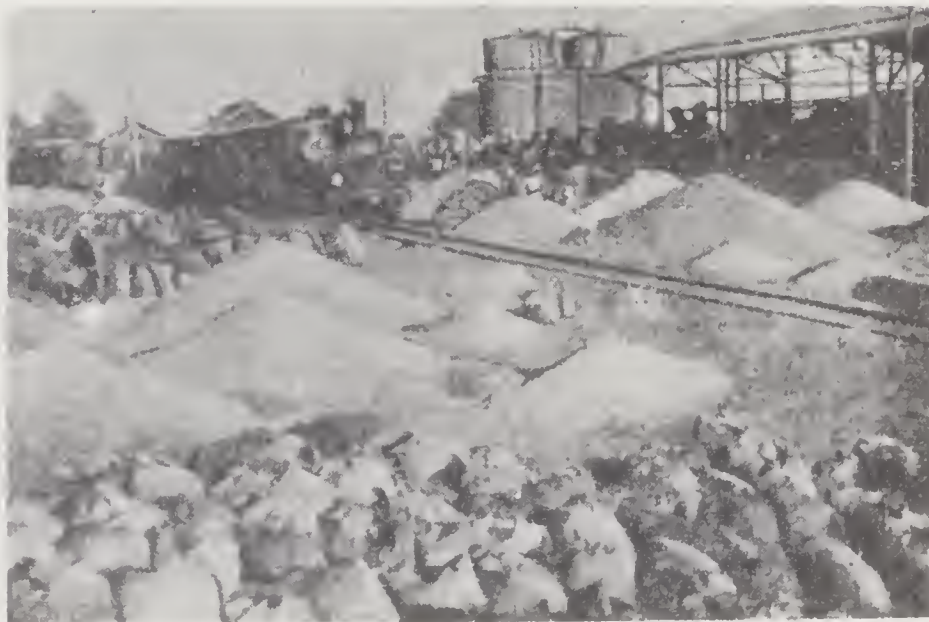
Syria, the Hauran. Rocky locality (basalt stones).
Triticum dicoccoides is found in large quantities



Syria, Beshri. Cedars of Lebanon



Syria. Threshing boards made out of stones in the Hauran



Syria, the Hauran. Grain depot near a railway station

- 15 New botanical forms of a number of crops were found, in particular, in ancient primeval areas of agriculture. Thus, the study of the Caucasus, Anterior Asia, Ethiopia and China led to the establishment of a number of new species and subspecies of wheat, as well as of new subspecies of barley, leguminous seed crops and flax (Linum usitatissimum L.). Entire geographical groups of local varieties were characterized by such valuable properties as compound immunity to various fungal diseases, resistance to low temperatures and drought, and large or small-sized grains. In Western Georgia, an entire group of endemic wheat species has been discovered, including Timopheev wheat (Triticum timopheevi Zhuk.), which is distinguished by an exceptional compound immunity to various diseases (Figure 1).



FIGURE 1. Timopheev wheat—
Triticum timopheevi
Zhuk. Transcaucasus



FIGURE 2. Persian wheat—
Triticum persicum
Vav. ("Wild"),
Georgian SSR

- 16 The high-altitude areas of Daghestan, Georgia and Armenia yielded a peculiar species of fungus-resistant quick-maturing spring wheat — Triticum persicum Vav.* — thereby distinguished by a grain which does not germinate on the root (Figures 2 and 3).

Among the species of cultivated Byzantine oats (Avena byzantina C. Koch) usually found in Mediterranean countries, the majority of forms were found to be immune to dusty and crown smut (Figure 4).

In the mountain steppe areas of Georgia, Armenia and Daghestan, assortments of local soft winter wheat have been discovered, closely resembling Banatka types which we called Prabanatka (Figure 5). In the foothill areas of the Northern

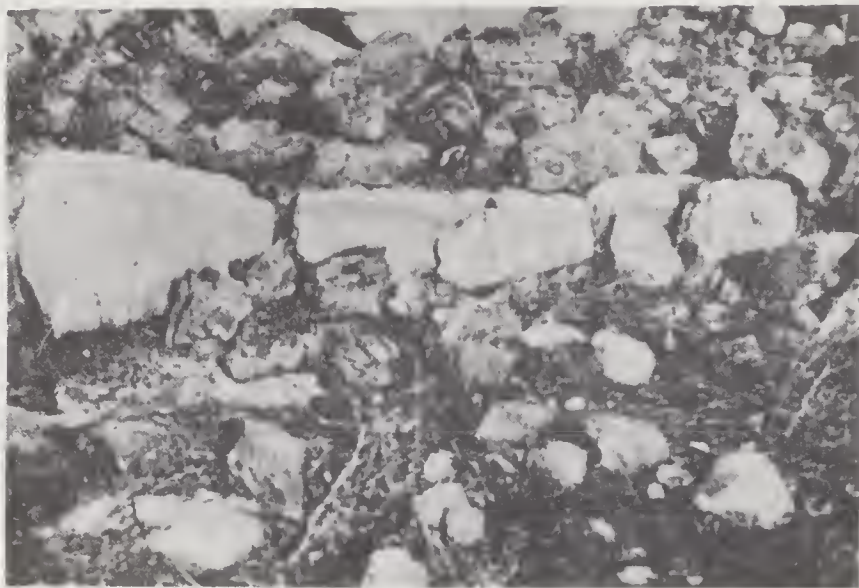


FIGURE 3. Persian wheat—Triticum persicum Vav. Daghestan ASSR



FIGURE 4. Avena byzantina C. Koch—Typical form of Mediterranean oats, Algiers

* Since Hemsley had used the appellation Triticum persicum to describe one of the species of Aegilops, S.A. Nevskii decided to change the name of this species of wheat to Triticum cartlicum (Vav.) Nevskii. However, the appellation Triticum persicum given by N.I. Vavilov must be retained, as it is widely known and by now accepted in the literature. N.I. Vavilov devoted a whole series of works to this species, for instance, in the fields of immunity and genetics. [Editor's note].



Transjordan. The Es-Salt area, where Triticum dicoccoides is found



Terrace cultivation in Druze villages of Northern Palestine



Palestine, Safed. Home of Triticum dicoccoides



Academician N.I. Vavilov's Caucasus expedition. Departure from Sukhumi on the road to Pitsunda (Gagersk District of the Abkhaz SSR). In the car Academician N.I. Vavilov, An.A. Fedorov, V.F. Nikolaev, and the driver A.I. Baïkov (Photo D. Raktin)

- 19 Caucasus, local varieties of winter barley have been discovered which are the most resistant in the world to winter conditions. These include forms characterized by an unyielding solid stalk. In the North of the European part of the USSR, as well as in Buryat-Mongolia, self-pollinating forms are found among ancient local types of rye (*Secale cereale* L.). In Abkhazia and in Azerbaijan (Lenkoran), strains of late winter spreading flax (Figure 6) have been found. When interbred with our usual long-fiber or intermediate-fiber flax, they impart a considerable increase in height to the stalks of the hybrid progeny.

The plentiful supplies of varieties from China, India, Australia, Argentina, Mediterranean countries and Western Europe permitted discoveries of new combi-



FIGURE 5. Soft wheat - *Triticum vulgare*
Vill., Kakhetin Banatka variety

nations of properties unknown in our country. It is sufficient to point to the beardless barleys of China and Japan, which are distinguished in addition by a solid straw, a small height, fine grain, and an accelerated ripening of the grain (Figure 7). Of particular interest were the Chinese wheats, especially those of the central areas of China, characterized by exceptionally rapid ripening of the grain, speedy maturation, ears with a large number of flowers, and immunity to yellow and brown smut. Local Mediterranean varieties of cereals, leguminous seed crops and flax prove to have exceptionally large seeds. The Spanish strains of soft wheat are characterized by a full or very stout straw, which is an essential property of defense against the sawfly (*Cephus pygmaeus* L.)

The most recent hybrid varieties of Canadian, Australian and South African

20 wheat are characterized by low stalks and strong straw, and are of special interest from the point of view of maximum yield for dense sowing.

The continuous and planned study of variety resources on a world-wide scale, in conjunction with a survey of the environmental conditions where they were developed, disclosed a large range of variety differences which had a great deal of significance for practical selection in different areas of our country.

As the study progressed, the operation of laws governing the geographical habitat of the various strains became evident. It became necessary to group these in a single, easily wielded system, which would include all the different species and varieties from the point of view of the plant breeders, so as to assist in the inclusion in selection of the most valuable starting material, having particular regard for problems of hybridization, with the aim of employing the most valuable components in cross-breeding. The present work was based on the study of extensive original initial material by means of frequently repeated sowings under different



FIGURE 6. Flax - Linum usitatissimum L., creeping form, Abkhaza ASSR

conditions, followed as far as possible by a thorough study, considering the circumstances in which the particular indigenous or selected variety was developed. A further basis for this work was provided by a study of the history of world agriculture and the selection and ecology of the individual agricultural areas studied, without which it would be impossible to grasp the specific features peculiar to any one of these areas. The basic purpose of this work is to assist the selectionist in getting to know and choose correctly the starting material suitable to different areas and different methods of selection; its goal in addition is to provide a survey of the world's grain resources from both the evolutionary and the geographical points of view. It thus aims to reveal the range of hereditary variability known today and to indicate future directions to be taken for the improvement of our most important cultivated plants.

To do this, we examined the chief spring and winter grasses associated by origin with the Old World, such as wheat (Triticum L.), rye (Secale L.), oats (Avena L.), barley (Hordeum sativum Jessen), leguminous seed plants (peas — Pisum Tourn.), lentils (Lens Adans.), grass peas (Lathyrus L.), chick peas (Cicer L.), broad beans (Vicia faba L.), vetch (Vicia sativa L.), and flax (Linum L.).



Caucasus. Academician N.I. Vavilov's expedition in Svanetiyu. Resting in a shepherd's hut (Photo D'yakova)



Caucasian expedition of the Academy of Sciences of the USSR in 1939. Picking wheat in Northern Osetia (village of Digori)



Caucasus. Valley in Southern Osetia
(Photo D'yakova)



Iran. Agriculture on rocky soil in a valley

The basis of the work was provided by the world-wide collection of the All-Union Institute of Plant Breeding, which encompasses in an exceptionally complete, if not completely exhaustive, manner all of the world's varieties of these crops. The scale of the work carried out may be judged by the number of samples of the above crops studied by the All-Union Institute of Plant Breeding (Table 1).

The greater part of the variety material was classified directly at the place of cultivation with, as a rule, an indication of the latitude, the elevation above sea level and agricultural conditions. This very large amount of material, which, as far as we know, has never been equaled, was subjected to study by all available methods. At the same time, it was placed at the disposal of all selection stations for purposes of practical selection.

When collecting variety material in various countries, the expeditions of the Institute of Plant Breeding paid a great deal of attention to studying the conditions of cultivation*. The selection of the crops examined was not fortuitous. We dwelt on the crops of the Old World mainly emanating from Hither Asia where the wild

Table 1

Number of samples of principal crops investigated by the
All-Union Institute of Plant Breeding

C r o p	Total number of samples studied	O r i g i n	
		From USSR	From other countries
Wheat.....	36,705	20,655	16,050
Barley.....	16,021	10,403	5,618
Oats.....	8,790	6,100	2,690
Rye.....	5,314	4,640	674
Flax.....	4,590	2,746	1,844
Peas.....	3,878	1,137	2,741
Lentils.....	2,222	975	1,247
Grass peas (chickling vetch).....	670	150	520
Chick peas.....	1,124	382	742
Beans.....	1,304	264	1,040
Vetch (sown).....	800	—	—

The author later makes nearly no mention of vetch. It appears only in the stippled agricultural maps together with other leguminous seed crops. [Russian Editor's note.]

parents most closely resembling these plants have survived to this day. These plants began to spread from this region of the world thousands of years ago in the same directions as man, and for this reason have much in common in their differentiation into ecological-geographical or agroecological groups. The geographical history of the introduction into cultivation of the above plants and the principal geographic location of their closest modern wild relatives coincide to a considerable extent. In essence, this group of crops formed the basis of most of the ancient

* See N.I. Vavilov and D.D. Bukinich, *Agriculture of Afghanistan*, 1929; P.M. Zhukovskii et al., *Agriculture of Turkey*, 1933; N.I. Vavilov et al., *The Wheats of Ethiopia*, 1931; N.I. Vavilov, *Cultivated Plants of the Khivian Oasis*; *Transactions of Applied Botany*, Vol XX, 1929; S.M. Bukasov, *Cultivated Plants of Mexico, Guatemala, and Colombia*, 1930; E.N. Sinskaya, *A Short Essay on Agricultural Plant Breeding in Japan*, *Transactions of Applied Botany*, Vol XXII, 1930, and others.

- 24 agriculture in the temperate zone of the Old World. A comparison of the species and varieties differentiation of these crops has made it possible to trace certain laws of their evolution. We have succeeded in showing in our book "The Centers of Origin of Cultivated Plants" (1926) that such crops as rye and oats were originally connected with wheat and barley and turned into independent crops from field weeds choking up the more ancient crops of barley, wheat and spelt as these crops migrated to the North and to high-lying areas. The book "Laws of Evolution of Cultivated Plants" (1940)* laid the theoretical foundations for the agroecological differentiation of cultivated plants. The present work provides concrete data on the individual crops in all the variety between their species from the point of view of the problems of practical selection.

The present work sums up nearly 20 years of work by the All-Union Institute of Plant Breeding in investigating the resources of the varieties of the most important field crops, and in so doing provides a great deal of information on the practical methods of selection, the objective being to provide guidance for creative work in this field. In studying the immense variety of types, a great deal of attention had to be paid to elaborating the actual research methods and systematizing the diverse type samples from the point of view of the selector. We wished to present a broad account, based on evolutionary theory, of the starting selection material, which must be the basis of future work by selectors. Detailed properties such as immunity to various infectious diseases and physical and chemical characteristics will require additional research in the future in connection with the elaboration of new methods. The present work is a first attempt to compile our actual knowledge of the world's resources of the principal varieties of cultivated plants into an integral whole as the basis for practical selection work carried out with the aim of increasing the quantity and elevating the quality of agricultural products in conformity with the various existing conditions.



FIGURE 7. Barley—Hordeum vulgare
L. var. Dundarbeyi Zhuk.
(of Japanese origin), Cilicia

* Manuscript.

Chapter I

PRINCIPLES OF AGROECOLOGICAL CLASSIFICATION OF
CULTIVATED PLANTS

As shown by the application of the methods of differential taxonomy, the Linnean species of cultivated plants consist of evolutionary, more or less individual morphophysiological systems of related forms readily cross-fertilizing themselves, associated in their genesis with a definite environmental area and thus with a definite tendency of geographical evolution, and divided into a greater or smaller number of ecogeographic or agroecological groups*.

Physiological differences, greater or smaller difficulties of cross-breeding and differences in the number and the structure of chromosomes determine the more or less pronounced individuality of the separate species. In accordance with this, our cultivated crops such as wheat, oats and potatoes are divided into a large number of species well-differentiated by a whole complex of features. The majority of species of cultivated crops, particularly those covering large areas, are made up of a very large number of well-differentiated hereditary forms. The differences include both morphological features and physiological properties.

The Swedish botanist, G. Turesson**, painstakingly developed a system of ecological differentiation of wild plant species in accordance with their habitat and climatic environment, and he introduced the convenient term "ecotype" to mean a group of plant forms within the confines of a single species which share an adaptation to a definite set of climatic conditions or a type of habitat within a certain climatic region.

Man may arbitrarily change the environment of and create new conditions for cultivated plants by means of irrigation, fertilization, nursing and alteration of the nutritional conditions. However, as already pointed out by a number of researchers — G. Gregor***, B. Bensin**** — cultivated plants still show ecological differentiation and may be classified into definite ecological types or, more precisely, 26 agroecotypes. By this we mean a group of plant forms belonging to a single species, adapted to a certain climate and soil under definite agricultural conditions and characterized by definite morphological features.

* N.I. Vavilov. The Linnean species as a system, Leningrad, 1931.

** G. Turesson. 1) The genotypical response of the plant species to the habitat, Hereditas, 1922, 11, Heft 3; Zur Natur und Begrenzung der Arteinheiten, Hereditas, 1929, XII, Heft 3; 2) The selective effect of climate upon the plant species, Hereditas, 1931, Heft 2, and other works.

*** G. Gregor. The ecotype concept in relation to the registration of crop plants, Ann. of Appl. Biology, 1933, Vol XX, No 2.

**** B.M. Bensin. Agroecological characteristics, discussion and classification of local corn (maize) varieties. Conference of the International Association of Plant Breeders in Prague, 1928.

Systematic research into the large number of varieties of cultivated plants collected in different countries, under different conditions, distinctly reveals the existence of laws governing their differentiation into agroecological groups. This is particularly evident in those cases where species have been widely disseminated over the globe in the course of their historical development and are today cultivated under various sharply differing conditions. Ecotypes are no less pronounced among cultivated plants than among wild species.



FIGURE 8. Flax - Linum usitatissimum L., Pskov, long-flax



FIGURE 9. Flax - Linum usitatissimum L., dwarf, moderate speed of maturation, Ethiopia

Cultivated flax may serve as a good example of the striking contrast between the agroecological groups. This is a crop which was already widely cultivated in ancient times in Asia, Europe and Africa. The various agroecological groups of flax, when cultivated under similar conditions, display great differences in height of plant, degree of branching of the stalks and dimensions of leaves, pods, seeds and flowers. Whereas northern Europe is inhabited by tall, single-system, small seed, long-fiber strains with a comparatively thick stalk (Figure 8), in Ethiopia, dwarfish, thin-stem, highly branched, small-seed forms (Figure 9) are cultivated, for the use of the seeds, which are ground into meal. Whereas Central Asian highly branched, low, small-seeded, oleaginous leafy plants, when transplanted under European conditions, are exceptionally susceptible to smut and other diseases;



FIGURE 10. Hard wheat—Triticum durum Desf., Ethiopia, Gondar area



FIGURE 11. Hard wheat—Triticum durum Desf., Ethiopia, Harrar area

- 28 coarse-seed, large-flower Mediterranean types of flax are characterized, under exactly the same conditions, by a small degree of branching and an astonishing resistance to disease. Forms with a creeping shrub have been discovered in the subtropical areas of Abkhazia, Azerbaijan and Asia Minor. As a rule, these plants are sown in autumn, i.e., in contrast to our usual varieties of flax, these are winter forms (Figure 6).

All these sharply contrasting forms are genetically grouped in a single Linnean species; they interbreed; as a whole, however, they represent the result of prolonged action by environmental and selective conditions.

While considerable morphological and physiological homogeneity exists within the confines of an individual ecotype, great diversity is quite often encountered in features not definitely connected with climatic conditions and habitat. Thus, for instance, hard Ethiopian wheats, which constitute a single well-defined ecotype (Figures 10 and 11) characterized by low height, rapidity of maturation, and resistance to being beaten down, at the same time display a striking variety of morphological features including color of the ear and grain, the kind of beard development, and the presence of awned or awnless forms. The polymorphism of Ethiopian wheats as regards morphological features is astonishing, but no less amazing is their homogeneity with regard to the ecotype.



FIGURE 12. Soft wheat - Triticum vulgare Vill.,
China

So varied are Chinese soft wheats (Triticum vulgare ssp. sinicum Vav.) that literally thousands of hereditary forms are known (Figures 12 and 13), differing as to density of ear, presence of completely beardless or short-beard forms, and immunity to brown and yellow smut. In fact, this ecotype of soft wheat is so different in morphological and physiological features that it may even legitimately be called a separate species, which may be subdivided into a large number of varieties. All nevertheless constitute a definite morphological entity associated with a definite ecological and geographical environment. Thus, certain widespread ecotypes really correspond to the usual botanical species and may quite often be distinguished as such, since they are physiologically and geographically differentiated from the original population.



Iran. Cultivation of stony soil with local implements



Iran. Threshing of wheat by horses



Iran. Peasant family near their meager wheat harvest



Iran. Wheat threshing

While the criterion for determining a botanical variety is above all provided by morphological features, which are the most contrasting ones, in practical selection the principal role is played by biological and physiological properties, as these determine the productivity, resistance to disease, and adaptability to given climatic and soil conditions.

Due consideration of agrotechnical factors is of great importance in evaluating various types of cultivated plants. These factors include cultivation conditions, sowing time (autumn or spring), regular use of crop rotation, use of irrigation (in arid areas) increase of soil fertility by the introduction of fertilizers, etc. None of these factors can but be reflected in the development of one or another aspect of the varieties. The evolution from harvesting by means of sickle and scythe to mechanical binders and combines has, in the last decades, led to a modification of varieties and the development of forms with a grain resistant to scattering, a solid stalk, and a lofty inflorescence. The pointed demands made by industry on the quality of vegetable raw materials are beginning more and more to highlight the role of "economic" features.

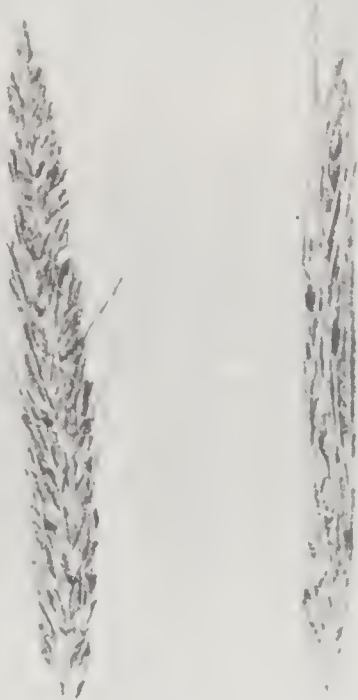


FIGURE 13. Soft wheat—Triticum vulgare Vill., N. China

Thus, the demands for modern practical selection making wide use of hybridization material have placed high on the order of the day the need for elaborating, in addition to the botanical systems, a new agroecological classification of existing varieties, the foundations for which must be provided by ecological, physiological and economically valuable features and properties. Our extensive world-wide variety material, systematically collected in various agricultural areas in the course of many years, together with due consideration of the agroecological data for the place of origin of the varieties and of their behavior in growth, as seen from comparative researches into the world-wide assortment by means of planting under various conditions, has made it possible to proceed with an agroecological classification of this kind.

Main Properties Taken as a Basis for Agroecological Classification of Cultivated Plants

Growing Period as Related to Climatic Conditions

Among the factors in the classification of varieties and their chief differentiation into ecotypes are climatic conditions. This is manifested with particular force with regard to biological and physiological properties. In all cases the climate determines whether it is possible to raise winter varieties, spring varieties, semi-winter varieties, late, maturing or early varieties, etc. The most important ecological property, for a variety is the length of the growth period, and profound differences are observed among the varieties in this respect. The growth period is determined by the reaction of the variety to temperature, light and moisture. This is manifest first and foremost in the vegetative period, which is genetically developed under definite environmental conditions. Natural and artificial selection produce forms adapted in the vegetative period to a given area. In such cases, the vegetative period is determined not only by the number of frostless days, but also by the time of appearance of summer droughts in arid areas or, on the contrary, under conditions of a monsoon climate, by the time of appearance of destructive downpours, which lead to damage by parasitic fungi, as well as by beating down the plant, germination of seeds in the head, and reduction of quality of the grain.

The temperature curve during the growing season plays an important role in producing strains of a given vegetative period. In this connection, the division into winter and spring forms is of important practical significance for annual grasses. This distinction is particularly pronounced in countries with a severe winter, where a very great difference exists between winter and spring forms. In such places, as a rule, only winter forms sufficiently resistant to winter conditions may be sown. Spring forms sown in autumn in these areas are usually destroyed by frost. The extremely severe winter conditions typical of considerable parts of Canada, Eastern Siberia and Mongolia, for example, have led to the cultivation predominantly of spring forms. In conformity with the climate, such countries as Ethiopia and North-West India, apart from Kashmir, are characterized by presence of spring varieties exclusively.

In countries with mild winters, for instance, Mediterranean countries, Argentina, Soviet Azerbaijan and foothill areas of Daghestan, spring varieties may be successfully sown both in autumn and early winter. Autumnal sowing of annual crops is characteristic for countries situated on the shores of the Mediterranean, especially in the plain and foothill areas. In selecting grades, it is highly important to select and develop forms which may make maximum use of the entire growing season for their development. Strains which are too early for the given conditions are less productive, since they make insufficient use of the possibilities of the growth season.

The vegetative period is a comprehensive notion. Types which under certain conditions are characterized by identical vegetative periods may be of a different physiological and genetic nature. The most varied results may be obtained when such varieties are interbred. The vegetative period, which to a certain degree reflects genotypic characteristics of the particular variety, at the same time depends to an extraordinary degree on external conditions.

Our geographical experiments carried out with given varieties on the territory of the USSR in 1923-1928, the works of Allard and Garner in America, and the later works of T.D. Lysenko and others have quite definitely demonstrated the dependence of the vegetative period on meteorological, geographical and other factors



Iran. On the Hamadan road



Kazakh SSR. Academician N.I. Vavilov's expedition to Kara-Tau in search of Tau-saghyz [*Scorzonera tausaghyz*, the black palsify], 1933-1934, Tau-saghyz found. At left, N.I. Vavilov



China, Sinkiang. The Irkeshtam-Kashgar Road. The expedition caravan



China, Sinkiang. The Irkeshtam-Kashgar Road. Transportation of cotton from Kashgar to the USSR

35 influencing the development of varieties. Forms which mature quickly under certain conditions may be late in maturing under others. As examples we may cite local barleys from the Archangel region, from the Komi ASSR, from the Karelian ASSR etc.* Yarovization (vernalization) makes it possible to sow winter and semi-winter forms in spring instead of autumn. Northern varieties are usually retarded at the stage of ear formation when transplanted in the South under conditions of a shortened day. Among the annual and bi-annual grasses, we distinguish at least two stages of development influencing the vegetative period. Their speed of development is determined both by genotypic characteristics and a whole set of external conditions.

The study of a large number of varieties of cereals and other annual plants (V.I. Razumov**) led to the establishment of a correlation between the length of the yarovization stage and the place of origin of the variety. Thus, winter wheats of Western Europe, particularly Scandinavian countries, are distinguished by an extremely protracted yarovization stage and require prolonged exposure to low temperatures. On the other hand, winter forms from southern, Mediterranean countries are characterized by a brief yarovization stage. The winter barleys of the Northern Caucasus require prolonged yarovization for the stem to be formed. In contrast to the above, the Syrian-Palestinian forms of semi-winter barleys require very brief yarovization. The majority of spring forms of barley and wheat cultivated in the forest, forest-steppe and steppe zones of the European part of the USSR and Siberia hardly react at all to yarovization in the sense of reducing the vegetation period. The spring forms of wheat and barley which trace their origin from Mediterranean countries as a rule react fairly markedly to yarovization.

We must distinguish between winter, semi-winter and spring varieties. The first are characterized, in wheats, barleys and rye, by the very pronounced occurrence of a marked yarovization stage of varying length, depending on the place of origin. Spring grades from Mediterranean countries, where they are quite often sown in autumn, also show a marked reaction to yarovization, as may be seen clearly from the example of lentils, vetch and lupine. Spring varieties from other areas, where they are sown in spring, or where there are no differences between winter and spring, for instance, Ethiopia and India, do not react to yarovization, or else show only a very slight reaction.

The varieties of annual plants may be divided into four groups according to their reaction to the length of the photoperiod: 1) those with a considerably shortened vegetative period as a result of a long light-day; 2) those with considerable acceleration of the vegetative period when the day's photoperiod is short; 3) an intermediate group; 4) neutral, which react hardly at all to either a long or a short photoperiod.

The length of the photoperiod affects varieties of different geographical origin in different ways. It often changes the general habitus of the plant, transforming a tall plant into a short one, a scantily-leaved one into a thickly-leaved one.

* F. Kh. Bakhteev. The Geographical Variability of the Length of the Vegetative Period of Different Types of Barley. Moscow-Leningrad, 1935.

** V.I. Razumov and M.I. Smirnova. Yarovization of Agricultural Plants in the Far North. Probl. severn. rastenievodstva (Problems of Plant Cultivation in the North), No 4, Leningrad, 1934, pp 47-59.

It has been determined that a profound dependence exists on the part of tuber formation in certain species and varieties of potatoes and other tubers on the length of the photoperiod. Certain South-American types and species of potatoes produce no tubers when grown in the North, as a result of the influence of the long photoperiod, and for these plants, normal tuber formation requires artificial darkening. In order to obtain tubers from such species and varieties, they must be covered for a few hours every day during cultivation. Certain varieties of southern rhizocarps give no thick roots when grown in the north. Radishes and turnips from India were studied by E.N. Sinskaya*; they formed no rhizocarp and became, as it were, oleaginous plants with a thin root.

The importance of the duration of the photoperiod as an ecological factor becomes particularly apparent when we employ a large variety of strains from different regions. For instance, it transpired from tests carried out by the Sub-Polar station of the VIR (All-Union Institute of Plant Breeding) that the majority of strains of the black-currant when subjected to a long photoperiod in the Kola Peninsula developed a floscule. As a rule, such strains do not bear fruit beyond the Arctic Circle. On the other hand, the Siberian strain of black-currant, picked along the Ob' River and near Igarka, proved to be adapted to a long light-day, and accordingly bore normal fruit at Khibiny. Evidently differences in intensity and quality of light are far from being negligible. This also applies to the role of ultraviolet rays in mountainous localities. The latter question has so far been insufficiently studied.

Rate of Development

The varieties of crops we have examined varied markedly in their rate of growth in the initial phase and in their later developmental rate. Thus, Mediterranean wheats, oats, and particularly flax, are characterized by accelerated growth at the beginning of development. Coarse-seed Mediterranean flax grown under steppe and forest area conditions in the USSR stand out sharply from the rest of the world-wide collection of flax varieties by their extremely rapid initial growth, far outstripping the strains from other countries. Pamir-Badakhshan barleys, which stand out because of their very elongated blades, are also characterized by accelerated developmental rates in the initial stages of growth. On the other hand, steppe forms of cereals are characterized by retarded initial development.

The differences in the growth rates of flax are particularly noticeable. Long-fiber flax, which lags noticeably behind Mediterranean flax at the beginning of growth, eventually overtakes it and ripens earlier. Such differences are known to be demonstrated to an even greater degree among tree species. For instance, many tree species of Eastern Asia grown under the conditions of our forest and steppe zones are characterized by spring flowering, before foliation occurs. On the other hand, American magnolia flowers in the middle of summer when grown on the shores of the Black Sea and the Caspian. Chinese and Japanese magnolia flowers here early in the spring, even before the appearance of leaves. As shown by research conducted by M.K. Firsova**, considerable differences are observed in the speed of germination of the seeds examined, and these differences may be used as a basis for classification. Whereas the hard wheats of Abyssinia germinate in a single day,

* E.N. Sinskaya. On the Nature and Conditions of Formation of Rhizocarps. Tr. po prikladn, botan. genet. i selekts. (Transactions on Appl. Botany, Genetics and Selection), Vol XVI, No 1, 1926, pp 3-35.

** M.K. Firsova. The Potential Germinating Power of the Seeds of the Chief Agricultural Crops of the USSR. Sots. Rastenievodstvo (Socialist Plant Breeding), 1936, No 17, pp 67-88.

- 37 the hard wheat of the Mediterranean require not less than two days to germinate under the same conditions. As has been shown by the research carried out by A. Yu. Tupikova-Freĭman*, the speed of germination is related to the size of the seeds.

Rate of Grain Filling during Maturation

The comparative study of the agroecological groups of cereal varieties has revealed sharp differences in the rate of the ripening of the grain at maturation. The extreme variants in this respect are the wheats and barleys of China and Japan, in which the formation of the grain under the conditions existing in the European part of the Soviet Union takes place in the course of a few days, while ripening in the strains of other groups goes on from two to three or four weeks. The accelerated ripening of East Asian forms is evidently connected with the influence of the monsoon climate. The summer downpours in Eastern Asia have led to the selection of fast-maturing forms. These properties also characterize the grain crops of India, a country possessing the same monsoon climate. Accelerated ripening is usually associated with fine grains. Reducing the size of the grains apparently leads to a reduction in size of the beard and sometimes even to the complete disappearance of the latter. Physiological adaptation has led to natural and artificial selection of beardless and short-beard barleys, wheats and rye, of the kind endemic to Eastern Asia and partly to India.

Response to Heat and Cold

The relationship of the variety to heat and cold, in both the first and last stages of development, is the next important factor determining the nature of an ecological type. The varieties of southern low-lying regions normally mature at high temperatures. Thus, for example, the hard wheats and leguminous seeds of Mediterranean countries require considerable heat for normal development. Central Asiatic wheats, even fast-maturing ones, suffer from insufficient heat in northern regions, particularly in the late stages of development.

Local northern varieties of cereals, leguminous seeds and flax are more resistant to low temperatures, and show extreme variations with regard to the low heat requirements. Such, for instance, are the wheats and oats of Finland and barleys and oats of northern Norway. High-altitude varieties of annual plants from the mountain areas of Ethiopia usually require little heat; hence the possibility of cultivating them in the North. The so-called Persian wheat (*T. persicum*) from the high-mountain areas of Daghestan, Armenia and Georgia matures in normal years under Moscow conditions and even around Leningrad and Arkhangel'sk (Archangel) (*var. fuliginosum*). Ethiopian high-mountain barleys and peas and Ethiopian black mustard mature fully even beyond the Arctic Circle.

Winter Hardiness

Resistance to winter conditions is of decisive importance for varieties sown in autumn. Destruction of varieties sown towards winter under the conditions of the European part of the Soviet Union and in Western Siberia is due to a number of reasons: low temperatures, rotting, soggianness connected with the stagnation of water in the soil, and other factors.

* A. Yu. Tupikova-Freĭman. Material for the Study of Spring Vetch in the USSR. Tr. po prikladn. botan. genet. i selekts. (Transactions of Applied Botany, Genetics and Selection), V 24, No 2, 1929-1930, pp 383-394.

Geographical laws are seen to be at work in the factors leading to the destruction of sown winter wheat, rye, and barley. Thus, low temperatures have a particularly pernicious effect in the Volga region, when there is a scant snow cover. In the Ukraine and the Northern Caucasus, winter-habited wheats and barleys are affected by freezing as a result of low temperatures, but also perish even at higher temperatures following debilitation induced by the ice layer, rotting, thaw and subsequent freezing, and abnormal hardening of the plants. Spring drought often has a pernicious effect on crops which have suffered during the winter. The roots situated in the cold layers of the soil do not then transmit sufficient water to the leaves which have already begun to grow. In the northern and central areas of the European part of the Soviet Union, winter varieties suffer from stagnant water underlying a deep snow cover. In the latter case, winter wheats and rye may become affected by the snow mold (*Fusarium nivale* Ces.). Anomalies are also observed in such cases with the hardening of plants occurring in the event of alternating thaws and freezes.

The nature of the resistance to winter conditions may differ for various areas: in the North, we must select for strains resistant to stagnant water and hibernating well under deep snow cover; in the Volga area, there is a special need for frost-resistant grains; in the Ukraine and Northern Caucasus we require wheat strains resistant to winter and spring temperature fluctuations. Geographical differentiation of the causes of destruction of winter crops appears particularly distinctly under the conditions of the USA. Low temperatures are the decisive factor in states where the overwhelming mass of winter wheat is concentrated (Kansas and Nebraska).

One of the most important principles of modern plant physiology is the dependence of a variety's resistance to winter dormancy on the extent to which it has previously been hardened (N.A. Maksimov*, I.I. Tumanov** and A. Akerman***). Strain differences in the nature of winter dormancy appear only when a definite hardening has been undergone. In a non-hardened state, even the most resistant varieties of winter cereals will not tolerate a fall in temperature. A change from cold weather to low frosts is necessary to ensure satisfactory hardening. The speed and extent of hardening differs for different plants.

Forms differing in the extent of frost resistance have evolved in different areas as a result of natural and artificial selection. For example, as has been shown by a study of the world-wide collection, the most frost-resistant forms of winter wheat are peculiar to the Volga area, the Ukraine, the northern and central areas of the European part of the USSR and to the Soviet Baltic Republics. As was shown by the severe winter experienced by Leningrad and Moscow in 1938-1939, exceptional resistance to winter conditions is characteristic of the forest and forest-steppe zone winter wheats of the Sandomir and Banat types, as well as of certain domestic and selected strains of Finland and Sweden. In contrast, even the high-mountain varieties of central Asia harvested at the altitude limits for cultivation, for instance, in the mountainous areas of Badakhshan (Afghanistan), at an elevation of 2800 m above sea level, were destroyed by frost during that severe winter.

* N.A. Maksimov. A Method for the Rapid Determination of Frost Resistance, *Semenovodstvo*, (Seed Cultivation), 1931, No 13, pp 16-21.

** I.I. Tumanov. The physiological elements of resistance of cultivated plants to winter conditions, Moscow-Leningrad, 1940.

*** A. Akerman. Frysningförsök med trad och buskar. Något om vaxternas koldöd och Frosthårdighet. In: *Prädgårdsodlingen i Sverige*. Stockholm, 1935, pp 269-272.



China. Sinkiang. Wheat stack near a Taranchi tribe village. Photograph, V. A. Dubyanskiĭ



Afghanistan. Tadjik mountain villages at the foot of the Saleng Pass, at an altitude of 2,450-2,700 m above sea level (southern slope of the Hindu-Kush)



Afghanistan. Peasant with plough near Kabul



Afghanistan. Wild watermelons in the Bak desert

Winter steppe wheat of the Banat type growing in the forest and forest-steppe zone are characterized by a high degree of resistance to winter conditions. These
 41 wheats gave rise to our strains most resistant to cold and winter conditions. It has already been noted that our winter barleys, which have the best resistance in the world to cold, evolved in the foothills of the Northern Caucasus. The Soviet Union also possesses most resistant strains of winter wheats. The United States and Canadian wheat varieties with the best winter resistance were adapted from the USSR. Spring wheats have been found in the high mountain areas of Afghanistan with considerable cold resistance (N.A. Maksimov)*.

The physiological method worked out by I.I. Tumanov for grading strains of grasses according to cold resistance by means of preliminary autumn hardening in the field makes it possible to differentiate strains accurately on the basis of this feature. First-hand experience has shown the necessity of distinguishing the chief winter-resistant types. In steppe areas characterized by snowless or only slightly snowy winters, the destruction of winter types is usually connected with a fall in temperature and is correlated with the resistance of plants to cold under definite conditions of hardening. In forest and forest-steppe areas with sufficient and sometimes even surplus humidity, conditions of winter dormancy are complicated by the damaging effect of surplus moisture. Direct experience gained in years of testing the most cold-resistant winter steppe wheats has shown that these endure winter conditions, as a rule, less well than typical boreal wheats of the Sandomir and the forest Banat types. A number of domestic and selected Swedish and Finnish strains and local varieties from the northwestern European part of the Soviet Union are characterized by both a high degree of cold resistance and a relative resistance to surplus moisture. Lathouwers** has shown that winter-resistant USA wheat varieties from the Great Prairies cannot endure comparatively mild winters.

G. Papadakis*** characterizes cold resistance of various ecotypes according to the separate stages of vegetation. He differentiates between susceptibility to frosts during the germination period and in the initial developmental stages (stages corresponding to plants' winter dormancy) and cold resistance during the ear-forming period and the maturation period. It is not always possible clearly to delineate the limits between these two types, but the differences are marked in the contrasting and characteristic varieties, and the selectionist must take them into account in choosing starting material for different areas.

Response to Soil and Atmospheric Drought

Resistance to soil and to air aridity is next on the list of important ecological properties. Research carried out by N.L. Udol'skaya**** and I.V. Krasovskaya***** has revealed the occurrence of different types of resistance to aridity in annual grasses. Certain strains are resistant to spring drought, thanks to slow growth in

* N.A. Maksimov. Intrinsic factors of plants' resistance to frost and drought. Tr. po prikladn. botan., genet. i selekts. (Trans. of Appl. Bot., Genetics and Selection), Vol XXII, No 1, 1929, pp 3-39.

** Lathouwers. Ecologie agricole. Dembloux, 1938.

*** J.S. Papadakis. Ecologie agricole, 1938.

**** N.L. Udol'skaya. Resistance of spring wheat varieties to drought. DAN, Rep. Ac. Sci. of USSR, Vol I, No 9, 1934, pp 583-589.

***** I.V. Krasovskaya. Physiological elements of selection and methods for gauging drought resistance. From the book: Theoretical Elements of Plant Selection, Vol I, Moscow-Leningrad, 1935, pp 783-806.

42 the first developmental stages. Of this type, for instance, are such standard varieties of Western Siberian spring wheats as Cesium 0111 and Milturum 0321. The other type of spring varieties initiates vegetation rapidly and for this reason is insufficiently resistant to spring drought; on the other hand, it is resistant at the later developmental stages. Such are the typical varieties of wheat, flax and leguminous seeds of Mediterranean countries. Hard wheats as a whole are characterized by this property. It is evident that it will later be possible to single out a few additional types characterized by a whole series of specific features in regard to drought factors. The selection of such physiological types is one of the next problems confronting the physiology of varieties. Research carried out by A.E. Votchal* has shown that a highly important factor in determining type differences in this respect is the nature of the conducting tissues. Differences in drought resistance are often reflected in structural peculiarities of the root network. For instance, according to the data of I.V. Krasovskaya**, the spring wheat varieties, Milturum 0321 and Cesium 0111, are characterized by a root network weighing twice as much as that of the least drought-resistant strains, Lutescens 062 and Prelude.

Normally, drought resistance is associated with slight foliation and scant growth. Drought resistance properties also depend on the stage of development and conditions of cultivation. Varieties which are drought resistant under certain conditions may prove to be non-resistant under others. For example, many strains of hard Syrian and Arabian wheat are extremely resistant to summer drought in their native soil, where they are usually sown around winter and may enjoy autumnal and early spring rainfalls. When these wheats are sown under USSR conditions, as a rule they have insufficient drought resistance.

In addition to differences in drought resistance, varieties differ in heat tolerance. Especially worthy of interest in this respect are varieties of annual plants from the torrid areas of South-West Asia and the dry uplands of Armenia and India.

Edaphic (Soil) Differences

Edaphic (soil) differences are also a determining factor in the formation of different ecotypes. Individual species and genera differ sharply in this respect. Thus, rye is more adapted than wheat to light soils. Isolated wild species of rye, for instance, Secale silvestre Host. (S. fragile M.B.) and S. vavilovii Grossh., are mainly found in sandy soils. Doubtless similar variety differences exist within the species. This is particularly evident in the example of wild forage plants. Thus, Z.N. Zhrebina*** has proved the existence of a sand ecotype of awnless brome grass (Bromus inermis Leyess) characterized by long rhizomes and a short stalk lying almost on the ground. In heavy marshy soils, on the other hand, a peculiar form of the same beardless brome grass has been found with short rhizomes. Several species of wheats, both of the monococcous (Triticum monococcum L.) and dicoccous type (T. dicoccum Schübl.) and true spelts (T. spelta L.) are markedly distinguished by their low demands on soil conditions.

* A.E. Votchal. The experimental study of dry wind on spring wheats, from the book: Theses of Reports Presented at the Conference on Plant Physiology, Moscow-Leningrad, 1940, pp 122-123.

** I.V. Krasovskaya. New developments in the study of plant root systems; from the book: Achievements and Prospects in the Field of Applied Botany, Genetics and Selection, Leningrad, 1929, pp 159-170.

*** Z.N. Zhrebina. The lessons of botanical and agronomical study of awnless brome grass (Bromus inermis Leyess), Tr. po prikladn. botan., genet. i selekts. (Trans. Appl. Bot., Genetics and Selection), Vol XXV, No 2, 1930-1931, pp 201-352.



Afghanistan, northern slope of the Hindu-Kush. Sorting wheat in the Kishlak of Modor



Ethiopia, Harrar area. Stack of durra



Ethiopia. Tilling a field near Gondar



Ethiopia, Addis Ababa . Bazaar, sale of sugar cane

45 In Germany, a great deal of selective work has recently been going on with the aim of developing varieties of wheat for light sandy soils. As L. Trabut* has shown, cultivated Mediterranean oats — A. byzantina — are characterized by tolerance of salty soils. Wheat field wild-oats and cultivated species of oats such as Avena brevis Roth. and A. strigosa Schreb. are usually found in light soils, and in Germany are usually called sand oats. In India, Howard** distinguished two types of cultivated flax differing as to root system: the first grows on the dense dark-colored soils of Deccan and has a strong, thick and powerful root system, while the other grows in the alluvial soils of the Punjab and the River Ganges valley, and is characterized by weak development of the root system.

Individual biotypes differ in regard to response to soil reaction. Rye and oats are more capable of enduring an acid reaction of the soil than are barley and wheat. Barley is considered to be particularly adaptable to alkaline soils. The Italian wheat variety, Mentana, withstands alkaline soils better than the Argos. Papadakis selected oats variety 32 Kielsallo, which grows satisfactorily even on alkaline soils. Leguminous plants cannot endure an acid soil, responding much better to a neutral reaction. This is particularly true of peas, beans and vetch. Lupine (Lupinus L.), on the other hand, grows best in acid soils, with an optimum of pH = 5-6; at pH = 7, the yield diminishes. It is known that such plants as lupine, serradella (Ornithopus sativus Brot.), and American types of grapes (Vitis labrusca L., V. rupestris Scheele, V. berlandieri Planch. and others) cannot endure calcium salts, i.e., are calciophobes. In selective practice in Western Europe, the different varieties are classified by the efficacy of the use of fertilizers. Certain authors, for instance Papadakis, assume that the problem of adapting varieties to soil fertility is connected with the degree of resistance to lodging and quite often also with resistance to winter conditions and drought. Papadakis noted strains differing in their reaction to soil aeration. Among the cereals, oats are the most resistant ones; among the wheats, Papadakis*** notes Canberra as the most sensitive in this respect (more so than the Italian varieties Mentana and Deves).

Germination of Seeds in Plants not yet Reaped; Duration of Post-Harvest Maturation

Individual species and varieties differ greatly in this respect. In general, we may observe the operation of definite geographical laws. Research carried out by M.K. Firsova**** has shown that Indian and Chinese wheats are characterized by resistance to germination of seed on the spike and by a long post-harvest ripening period. As a result of the characteristics of the monsoon climate in these countries, forms have been evolved which germinate exceedingly slowly on the root after ripening. This slow germination is an adaptive feature which is associated with the arrival
46 of the rainy season towards the end of the harvest season. According to our observations, this feature is characteristic of Triticum persicum and certain hull-less,

* L. Trabut. Culture dans les terrains salés. Gouvernement Général de l'Algérie. Inform. agric. serv. botan., No 69, Alger, 1927, pp 1-8.

** A. Howard and G. Howard. The Development of Indian Agriculture. 1929.

*** J.S. Papadakis. The Australian Wheat Canberra, and the Italian Wheat Mentana in Greece. Salonica, 1933, No 14, pp 25-43.

**** M.K. Firsova. A Natural Method for Accelerating the Germination of Ripe Wheat Seeds on the Basis of a Study of their Separate Stages. Tr. po prikladn. botan., genet. i selekts. (Trans. Appl. Botany, Genetics and Selection), ser. 4, No 2, 1937, pp 57-66.

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

two-rowed barleys in the mountains of Daghestan. Compact sheaves of barley and Persian wheat lie for weeks under rains and strong dew without germinating. And conversely, in Central Asia, for instance in the Gorno-Badakhshan region of the Tadjik SSR, as well as in all inland areas of Iran and of Afghanistan, wheat and barley varieties germinate readily on the spike, and their seeds are characterized by brevity of post-harvest ripening. In the North, varieties have been evolved which often have excellent resistance to germination on the spike in ripening. The extreme variant in the sense of a tendency to germinate on the spike are hull-less Asian mountain barleys cultivated in their native region under conditions of an extremely dry summer, as a rule under irrigation. Under normal European conditions, they are characterized by an almost complete absence of a post-harvest ripening period, and germinate correspondingly rapidly on the spike in rainy weather.

The appearance of marked physiological contrasts, as far as this particular feature is concerned, is connected with definite environmental conditions and with the action of natural selection.

Infectious Diseases and Insect Damages

The incidence of infectious fungal, bacterial, and viral diseases, as well as damage by insects, is related to climatic and soil characteristics and the fact that land changes hands now and then, and these are often the chief factors limiting the growth of plants or particular ecotypes. The biology of parasitic fungi is highly varied, as is their relationship with environmental factors. Thus, stem-rust (*Puccinia graminis* Pers.) develops particularly in the later period, before ripening, when the weather is warm and somewhat damp. Yellow rust (*P. glumarum* Eriks. et Henn.) develops favorably under low summer temperatures. Like all species of rust, stem-rust reacts favorably to humidity, but in this respect is less demanding than brown (*P. triticina* Eriks.) and yellow rust. Quite often the development of wheat cultivation in warm countries is considerably hampered by the development of stem-rust. Yellow rust, as a whole, may be described as a rust peculiar to countries with a cold, damp spring.

One of the most important factors influencing the growth of barley and spring wheat in the Leningrad, Voronezh, Moscow and certain other regions is the fatal action of the Swedish fly (*Oscinis frit* L.). Exceptionally severe damage to barleys is caused by this fly in the foothill and low-lying areas of Daghestan. In the humid foothill areas of the Northern Caucasus and the Far East, one of the vital factors in cereal cultivation is the existence of different species of smut. In Northern Europe, wheats and barleys often suffer from damage by powdery mildew (*Erysiphe graminis* DC.).

Under the arid conditions of Central Asia, Iran and Afghanistan, where air humidity is very low and plant growth is made possible only by irrigation, smut does not, to all intents and purposes, play a serious role. Under Far Eastern conditions, where maturation proceeds slowly, insufficiently quickly maturing wheats are badly damaged by fusariosis owing to abundant humidity. The development of ordinary cereals and a number of other crops is quite often almost impossible under moist tropical and subtropical conditions because of the massive development of parasitic fungi and damage by various species of insects.

In conformity with environmental conditions and the presence or absence of infection among ancient varieties peculiar to definite areas, forms have been developed which differ sharply in their resistance to damage by various infectious diseases.



Egypt. On the edge of the desert



Threshing wheat in Lower Egypt



Egypt. Traveller resting in the desert.



Greece, Thessaly. Harvesting crops

The research we carried out on our entire world-wide collection of varieties under various conditions, including both natural and artificial infection, has uncovered great inter-species and intra-species differences in resistance to infectious diseases. Many strains of wheat and barley from Central Asia and Iran when grown under conditions favoring infections in the steppe, forest and forest-steppe zones of the USSR act, as it were, as accumulators of all species of smut. The study of a large number of varieties has shown that definite laws govern the behavior of different agroecological groups of varieties in respect to parasitic diseases. Thus, practically all local varieties of wheat, barley, rye, flax and leguminous grains of the large Iran-Turkestan arid agroecological region are characterized by a very marked susceptibility to typical diseases under European conditions. Conversely, flaxes, wheats, barleys, and to some extent leguminous grains, grown in Mediterranean countries, are characterized by considerable resistance to smut and a number of other infectious diseases. The overwhelming majority of Mediterranean oats are characterized by exceptional resistance to black smut and crown smut. In contrast, the overwhelming majority of European varieties of ordinary oats (Avena sativa) are susceptible to black and red smut. Individual agroecological groups of two-grained cereals differ sharply in their resistance to brown, yellow and stem-rust, and also to powdery mildew. Volga spelt, as well as Persian, are characterized by exceptional susceptibility to yellow rust and powdery mildew. In contrast, west European two-grained varieties (Triticum dicoccum) are characterized by high immunity to these fungi, as well as to brown rust. In North-West India, German researchers found soft wheats resistant to powdery mildew*.

Research carried out by P.G. Chesnokov has revealed that a definite connection exists between agroecological groups of wheat, oats and barley and their behavior in regard to the Swedish fly, Hessian fly (Mayetiola destructor Say.) and green eyes (Chlorops pumilionis Bjerk.). Immunity or susceptibility to fungal diseases, as well as behavior in regard to parasitic insects, is thus a highly important ecological property.

In estimating the varying action of species of parasites on the different physiological strains, we must bear in mind the behavior of the different varieties with regard to the various types of parasites. Strains resistant to one type may be damaged by another. Hence the exceptional importance of selecting for group or compound immunity of the kind manifested at the same time in respect to various species and types of parasites and to different physiological races. Research we have carried out over the last three decades has shown that phenomena of group immunity are widespread and has determined the basic laws which govern them. The extent of group immunity is related to the degree of specialization of the parasites and to the genetic and ecological differentiation of species and varieties**.

Agronomic Conditions

Cultivation exerts a great influence on plant types, as may be seen by comparing cultivated forms with the corresponding wild ones. The mere tilling and loosening of the soil, and the destruction of weeds create new conditions not existing naturally. The change-over in the nineteenth century from the primitive Roman or Arab plough, which, in fact, was a harrow only loosening the soil, to the modern European plough, which turns up the soil, led to even more radical changes in the soil substratum.

* Deutsche im Hindukush. 1938.

** N.I. Vavilov. Laws of Natural Immunity of Plants to Infectious Diseases (in manuscript).

The most far-reaching form of intervention by man in changing environmental conditions is the use of artificial irrigation, already practiced in earliest antiquity. Agriculture with the aid of irrigation has been widely used from time immemorial in Mesopotamia, Iran, Central Asia, India, Egypt and China. The use of irrigation in ancient Mesopotamia and Egypt dates back, according to documents, to not less than six thousand years ago*.

In pre-Columbian America it was widely practiced in the period of Incan civilization. To carry out irrigation in these ancient agricultural areas, much work was required to lay in irrigation systems, build aqueducts and canals, and create water reservoirs. In Iran, and to some extent in Turkmenia and Afghanistan, peasants for thousands of years have been using the labor-wasting method of digging galleries under the earth. These were called "kyariz", and often led the water into the fields from sources many kilometers distant. Irrigation is used in both low-lying and mountainous areas. Peasants of the mountain and desert areas of Central Asia, the Pamirs and Tibet already used artificial irrigation in antiquity; without it agriculture would be unthinkable here.

By radically changing moisture conditions and creating conditions favorable for cultivation, the primitive peasants provided an impetus to the development of suitable varieties. Irrigation conditions not only provided the possibility of combating drought, but also helped to make a more rational use of the prolonged growing season. Thus, for instance, in north Afghanistan, on the irrigated lands in the Hari River valley, near Herat, a late-maturing high-yield species of wheat called "Zafrani" (Triticum turgidum L.) has been widely grown from time immemorial after having been imported from Mesopotamia. On the other hand, on non-irrigated land in this region, domestic varieties of soft wheats are grown which are exceptionally resistant to drought. Whereas in the foothill areas of Central Asia there are sometimes no differences between irrigated and non-irrigated varieties, thanks to their frequent interchanging, in the mountainous areas of Central Asia, the Himalayas and Tibet, characterized by a more stable irrigated agriculture, we may observe the exceptional role of irrigation in the development of the corresponding type of variety. In complete defiance, as it were, of the desert climatic conditions peculiar to these areas, we here find in irrigated agriculture characteristic broad-leaf hull-less six-rowed barleys with spongy tissue. Such varieties can exist only if watered. The peculiar non-ligulate varieties of wheat of the Pamir area, Shugnan, Roshan and Badakhshan, which are characterized by vigorous development, as well as the original giant Pamir spring rye with a large grain, large ear and large anther, are grown exclusively on irrigated soils. Under irrigated cultivation conditions of the desert areas of Peru, as long ago as during Incan civilization, there evolved a peculiar late-maturing type of corn with exceedingly large grains. Only under irrigated agricultural conditions, that is of sufficient water, could giant forms of cultivated melons be developed in Central Asia, in sharp contrast to the wild small-fruit melons (Melo Adans., Sectio Bubalion Pang.) growing alongside on non-irrigated land, with dimensions sometimes not exceeding those of a large plum.

In the Old World, as agriculture moved towards the north, man's efforts were directed to fighting excessive moisture by the use of artificial drainage. The development of agriculture in Southern Sweden, Denmark, North Germany and Finland is linked with the wide development over hundreds of years of both underground and surface drainage. The use of drainage in northern areas radically modified moisture conditions and created a favorable environment for winter dormancy of winter

* I. Lur'e, K. Lyapunova, M. Mat'e. B. Plotrovskii, N. Flitner. Outlines of the History of Agrotechniques in the Ancient East. Akademiya Nauk SSSR (Acad. Sci. USSR), 1940.

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX
cereals and perennial forage grasses, **accelerated growth and produced favorable**
conditions for harvesting at the proper time.



FIGURE 14. Spelt wheat - Triticum spelta L. , Spain

In accordance with the agricultural conditions, we must differentiate between the ecotypes of irrigated and non-irrigated lands. We have seen that the varieties of cereals are differentiated according to the degree of endurance to disease. We have already pointed out that North European varieties of winter wheat are characterized by great resistance to cold; these also display a greater ability to endure excessive moisture, in contrast to steppe winter wheat, which evolved under conditions of insufficient moisture.

Land Fertilization

The fertilization of fields also led to the development of corresponding ecotypes. The use of various kinds of fertilizers was already practiced in times of the most ancient antiquity, in Egypt and Central Asia, and particularly in China and Japan. The giant forms of vegetables which have evolved during thousands of years in China, Japan and in countries on the shores of the Mediterranean have definitely been connected with the use of fertilizers. The development of the use of chemicals in agriculture in Western European countries during the past century and the intensified application of mineral and organic fertilizers in connection with the development of cattle raising placed high on the agenda the task of creating types which could make use of fertilization with the maximum of efficacy.

As already noted, during the last decade the attention of breeding experts in Germany, Denmark, Sweden and England has been directed to a considerable extent to the development of varieties of cereals able to utilize fertilization particularly effectively. To a large extent this was connected with the attempt to develop nonlodging varieties under appropriate conditions of culture. Ancient types of cereals which evolved in the past under poorly developed conditions of agrotechnics, became characterized by a tendency to lodge.

The study of the world's varieties of grain agriculture reveals vast differences in this respect within the individual species. Thus, many local grades of Japanese and Chinese barley are characterized by a strong straw. Such species of wheat as T. compactum Host., T. spelta and T. sphaerococcum, Perc., are characterized by a strong stalk (Figures 14-19).

Soft wheats from Baluchistan and India are characterized as a group by a strong stalk in all the varieties. As a result of the use of a large number of fertilizers in Western Europe, the sharp increase of the yields has been accompanied by a trend to grow wheats of the "square-head" type, characterized by



FIGURE 15. Club wheat - Triticum compactum Host., Afghanistan



FIGURE 16. Club wheat - Triticum compactum Host., Sunpan

a strong, thick stalk. Many English varieties of barley are characterized by a compact ear and strong straw.

The wide use of mechanized harvesting with reapers and combines has recently made it imperative to grow varieties characterized by stronger straw. Such varieties are created by cross-breeding European and Indian forms of spring wheat. On the whole, the majority of standard modern varieties of spring wheat in Canada, U.S.A., Argentina, Australia and South Africa is characterized by a strong stalk. It is highly important that a series of local varieties of wheat and barley is also distinguished by a comparatively strong straw evolved under appropriate conditions. In this respect, the extreme variant is the Indian species *T. sphaerococcum* (Figure 18). A comparatively strong straw is characteristic of a number of local and Western European varieties of winter and spring wheat. The Ethiopian sub-species of two-row and six-row barleys is characterized, as a whole, by a strong stalk. Among the local winter barleys, in the Northern Caucasus we succeeded in the Mosdok area in finding a six-sided winter barley characterized by a thick, strong stalk. Among the leguminous seeds fasciated in the case of forms with strong stalks, were discovered sometimes pea and chick pea. Beans are characterized by a strong stalk.



FIGURE 17. Chinese club wheat - *Triticum compactu*
Host. China

While the most important task of the immediate future in many areas of the USSR is to grow varieties which will be resistant to lodging and able to tolerate the use of heavy fertilization and highly developed forms of agro-technique.

Crop rotation changes are similarly reflected in the development of definite ecological types and varieties. The elimination of lands lying fallow for many years, according to the practice in our country and other countries, led to substantial changes in environmental conditions, and thus to a change in the types of varieties. The replacement of hard wheats by soft in the Trans-Volga area and also in Algeria and Tunisia during the past decades is connected with the elimination of the protracted fallow period system. Hard wheat suffers from weeds more than soft wheat at the beginning of growth. Many years of leaving the land fallow created favorable conditions for cleaning out the fields, improving the structure of the soil and accumulating nutritious substances. Although, as shown by direct experience, hard wheats may be grown in an absolutely satisfactory manner in fields ploughed a long time ago, this is possible only under conditions of proper treatment of the soil and elimination of weeds. In the past, such weeds were associated chiefly with the system of allowing fields to remain fallow.



FIGURE 18. Round grain wheat - Triticum sphaerococcum Perc.



FIGURE 19. Round grain wheat - Triticum sphaerococcum Perc., Punjab variety

The use of intensive crop rotation and the introduction of crops designed for efficient reaping created the task of growing appropriate, rapidly maturing varieties.

Evolution of Harvesting Methods

In the same way, the evolution of harvesting methods could not but be reflected in the types of varieties.



FIGURE 20. Yemen two-grained wheat -
Triticum diococcum Schübl.
Yemen

In the areas of Southwest Asia, with a dry climate and under conditions of a nomadic or semi-nomadic economy, where the harvest takes a long time and plants remain in the field long after they are ripe, there has been a corresponding evolution of non-shattering varieties of wheat, rye, and leguminous seeds.

5161



FIGURE 21 Cultivated two-grained wheat (spelt) — Triticum diococcum Schubl. Volga area



FIGURE 22 Cultivated two-grained wheat (spelt) — Triticum diococcum Schubl. Ethiopia

In Chinese Turkestan and in the Khivin oasis, until a short time ago, Asiatic varieties of cotton - Gossypium herbaceum - were widely cultivated. It has a completely closed boll which preserves the fibre for a month after ripening. Soft dwarf wheat of Central Asia is characterized by the tight enclosure of the kernels within scales, making it possible to maintain them in the field for months. Hard wheats, extensively grown in the Mediterranean countries, as well as in our steppe areas, are also characterized by non-shattering properties. The extreme in this connection is the two-grained variety (Figures 20-22) and the wild and cultivated oats contaminating German wheat fields (Figures 23 and 24).



FIGURE 23. Avena sativa L. — Field weed oats from field sown with spelt. Georgian SSR, Skhuchalak area

Conversely, in high altitude areas, where the growth period is usually short and where because of the fatal action of frost, the population has carried out accelerated harvesting from ancient times, without even waiting for complete ripening, there correspondingly evolved a type of variety which is easily threshed

58 and readily sheds its grains, as is characteristic of many northern wheats and barleys.

The use of harvesters and combines in recent decades has led to the growth of varieties with a strong straw and a high-placed inflorescence. We accordingly note marked changes in the varieties of such countries as the USSR, Argentina, the USA, Canada, and Australia, where wide use is made of mechanized harvesting.



FIGURE 24. *Avena sativa* L. Field weed oats from field sown with spelt. Georgian SSR, Gori area

Trends of Selection

Cultivated plants are the result of the action on the plant of the environment in the broad sense of the word, including both climatic and soil conditions, as well as the activities of man. This whole complex of factors shows its influence by a definite trend of selection and the evolution of the appropriated adaptable forms.



Greece, Thessaly. Harvest of English wheat



Island of Cyprus. A bazaar in the town of Nicosia



Island of Sicily, harvesting of horse-beans



Algeria. Threshing wheat by running work animals over the grain (near Setif)

Artificial selection is of great value in developing definite types of cultivated plants. The history of world plant breeding shows quite clearly the extraordinary role of selection in the development of cultivated plants. The works of Theophrastus, Columella, Varro and Virgil, composed over 2,000 years ago, contain indications of how to perform selection. Varieties from China and Japan, from the Mediterranean countries, from Peru and from Central America astonish us by their degree of domestication and their marked differences from the corresponding wild forms. We sense in them the products of great selective labors. In the ancient areas of irrigated agriculture in Peru have been found varieties of corn included in the so-called Kusk category, the size of whose grain was three or four times larger than the usual North American varieties. Excavations have shown that large-seed Peruvian corn was known at least 1,000 years ago, and certainly during the Incan civilization. Contemporary genetic experts have still not succeeded in exceeding the size of the Peruvian corn grains. Leguminous crops of Mediterranean countries represented by chick peas, lentils, grass peas (chickling vetch), beans and peas, are characterized by the large size of their kernels, which exceeds by several times the dimensions of varieties of the same species grown in Southwest Asia. Mediterranean flax has seeds and bolls of twice the size of those in Central Asia.

Many vegetables have undergone extreme changes as the result of selection. A truly astonishing example may be provided by cabbage varieties. Chinese vegetables are a rather remarkable result of selective creativity. Varieties of Chinese *Vigna* attain bean dimensions of 50 and more centimeters. A masterpiece of Japanese selection is the famous Sakurajima horse-radishes, grown on the island of Sakurajima in Southern Japan, near Kagoshima, which attain the weight of a pood*.

In the old areas of intensive agriculture near Valencia, Spain, the weight of the ordinary onion reaches one kilogram. In the Arab gardens in the suburbs of Algiers we succeeded in collecting ordinary onions of upwards of two kilograms in weight.

Depending on the degree of care and selection, the varieties of the ancient agricultural vegetation of the Old World differ greatly as to quality. In contrast to the large-seed varieties characteristic of the Mediterranean areas, the varieties of leguminous seed crops, flax, and to some extent wheat grown in Southwest India and Afghanistan, are characterized by small seeds and small fruits (Figure 25). The lentils of Northwest India and Eastern Afghanistan approach the wild forms in the smallness of seeds and darkness of color, and even preserve the feature of the splitting of the beans (Figures 26 and 27).

An astonishingly small size of seeds is also characteristic of the beans, peas, grass peas (chickling vetch), and chick peas of Northwest India and Northeast Afghanistan (Figure 28).

At the same time, the agroecological groups of crops of these areas are characterized by a number of valuable properties, such as resistance to drought and speedy maturation.

The results of recent selection are markedly reflected in the modern varieties of West European agriculture. It is sufficient to compare the ancient local varieties of Swedish and England wheat with the modern varieties, with their square-headed form, large ears, strong straw and wide leaves.

The action of natural and artificial selection is quite often inseparable. It is often difficult to say what is the result of natural selection and what of

* [A pood - 36 lbs].

62 artificial selection. Thus, in China and Japan, peculiar beardless and short-bearded forms of barleys were evolved, as already mentioned above, while these were unknown in the original focal birthplace of cultivated barley in South-west Asia. Barley, like wheat, is a crop foreign to China. But here, under special conditions of the monsoon climate, both barley and wheat underwent the powerful action of natural as well as artificial selection. As a result, original forms were formed which are not met with in other countries, including beardless and short-bearded barleys and beardless and short-bearded forms of wheat



FIGURE 25. Sown peas - Pisum sativum L.,
Afghanistan

with multi-florous ears and a fine grain. But we have already pointed above to the specific characteristics of the barley and wheat varieties of China which, as a result of the environmental conditions, are distinguished by an accelerated ripening of the grain, in accordance with which, exceptionally fine-grained forms have evolved. Even the short beard or beardless feature is apparently connected with the decrease in size of the kernel, economy in the use of structural substances, and the accelerated development of reproductive organs. The influences



FIGURE 26. Lentils - Lens esculenta Moench var. afghanica Bar. Afghanistan

- 64 of natural and artificial selection are here intertwined, and apparently what is usually ascribed to the action of artificial selection is, to a considerable extent, the result of natural selection. Natural and artificial selection also apparently operate simultaneously in the development of large-seed forms. Mediterranean climatic conditions, where the rainfall occurs in late autumn and early spring,



FIGURE 27. Lentils - Lens esculenta
Moench var. indica Al. India

favor the development of forms which grow most quickly at the outset. As a rule, large-seed forms develop more quickly, and thus natural selection here favored the survival of large-seed forms, which was also the aim of artificial selection.

In the far north, for instance in the Archangel region, on the one hand, and in Buryat-Mongolia, on the other, as the result of unfavorable conditions for flowering in overcast wet weather, which hindered the free dissemination of pollen by the wind, and thus the influence of natural selection, there developed a peculiar local winter rye prone to self-pollination. In the far north, apparently as a result of natural selection, a number of forage crops evolved, for instance meadow grasses (Poa alpina L., P. alpigena, Fries. Lindm), with



FIGURE 28. Chick pea - Cicer arletinum L..
India

a tendency to apogamy. The fact that a large number of varieties resistant to brown and yellow rust, including early-maturing ones, are concentrated in Central and Southern China is the result, above all, of natural selection.

An exceptionally strange result of selection is sometimes connected with the unintentional use of inbreeding. In the agriculture of isolated oasis of Central Asia, for instance, the oases of Yarkand, Kashgar, and Hutien, in Chinese Turkestan, peculiar, white-seeded, narrow-petaled flaxes with white flowers, which are more reminiscent of star flowers than normal flax, are common (Figure 29).



FIGURE 29. Curly flax --- Linum usitatissimum L., with crinkly petals (in the ovals), China, Kashgar, Yangigesar

In the isolated Khivin oasis, in the lower reaches of the Amu-Dari river, white-seeded and white-flower flaxes are also wide spread (Figure 30). In Badakhshan and Shugnan, which are adjacent to the Pamir mountains, we found large quantities of unique recessive, unligulated forms of wheat and rye (Figures 31, 32). All these forms are genetically recessive and arose apparently in consequence of the action of the isolation factor, which ensured the prevention of cross-fertilization. Quite often such forms are encountered in mixtures, and sometimes selected by man in pure areas, as could be observed for instance, in connection with white-seeded flaxes.

An extremely peculiar group is the result of the phenomena of the simulation of one species by others, sometimes even of different genera and families. We discovered a large number of facts attesting to such a simulation when different species of wheat undergo protracted mixed cultivation. Thus, in the foothills of Daghestan, in the areas sown with hard winter wheat, a peculiar soft wheat has developed with a dense head and a scale structure, dimensions and vegetative features corresponding to the hard-wheat crop among which it grows. In Ethiopia we found a large number of varieties of soft wheat with an ear and general habit simulating the species of T. durum Desf. and T. turgidum among which they grew. In Syria, among cultivated areas of horanicum wheat (T. durum var. horanicum Vav.), we found dwarf wheats whose ears were difficult to distinguish from horanicum. Certain forms of wheat - T. macha Dek. and Men. - are also only distinguishable with difficulty from winter emmer from Western Georgia, where they grow together (Figure 33).

In high-lying Daghestan and in Georgia we found a large group of soft spring wheats, similar as regards their general habit and morphology of the ear and grain to T. persicum and differing from this only in the number of chromosomes



FIGURE 30. Curly flax—Linum usitatissimum L., white-colored, late-maturing, Khiva



FIGURE 31 Rye - Secale cereale L. Details of the ligulated form. Pamir



FIGURE 32. Rye - Secale cereale L. Details of the ligulated form, as in sedges

68 and differences in susceptibility to parasitic fungi. This highly interesting class of facts illustrating the powerful action of natural and artificial selection, which in this particular case are not sharply delineated, bears witness at the same time to the high hereditary plasticity of *species**. We discovered even more astonishing facts in connection with weeds contaminating various cultivated crops. Thus, in the areas sown with emmer in the Kama Region, we found a peculiar oat with small ears which did not disintegrate at maturation



FIGURE 33. Macha wheat - *Triticum macha*
Dek. et Men. Georgian SSR

and a very marked articulation of the flowers, differing in this respect from normal oats. These oats, which we accordingly called German wheat-field types, are difficult to distinguish from the heads of German wheat and, at harvest, go to the granary together with the primary crop. Such German wheat-field oats have been found by us in other areas where two-grained emmers are grown, their appearance changing in correspondence to the different ecotypes.

71 In Portugal, in areas sown with branched wheat (*T. turgidum*), we found a peculiar form of *A. brevis* with distended ears, called *A. brevis* var. *turgida* Vav., the dimensions and forms of whose grains made it resemble the *T. turgidum* among which it grew (Figure 34).

* N.I. Vavilov, Theory of the origin of cultivated plants after Darwin. Sov. Nauka (Soviet Science), No 2, 1940.



Vegetable and fruit market in Tunis



Japan. Usual method of drying corn on the cob on the island of Hokkaido



Japan. Threshing of adzuki beans [*Phaseolus angularis*] on the island of Hokkaido. Typical jointed bamboo flails



Japan. Well-tended fields of rice near Hakodate

- 71 In high-lying Daghestan, we found among flax fields varieties of the gold-of-pleasure with small pods and seeds reminiscent of flax. In general ecotype, height of plant and time of ripening, the weed forms of the gold-of-pleasure (Camelina sativa Crantz.) were completely similar to the main flax among which they grew. Among the original relic form of cultivated creeping flax (Linum crepitans Dum.) which differs from the usual flaxes by the features that the pods open at maturation and the seeds are shed, i.e., essentially by the features of wild flax, E.N. Sinskaya* also found forms of this gold-of-pleasure with pods which open widely at maturation.



FIGURE 34. Avena brevis Roth, var. turgida, Vav. - Short oats in fields sown with wheat Triticum turgidum L., Portugal

Natural selection and artificial selection exert an intimate joint action. The role of man in this connection is hard to separate from that of natural factors. All these considerations must be borne in mind when presenting a description of agro-ecological groups of varieties.

Industrial Requirements for Plant Raw Materials

The demands of industry for vegetable raw materials have left a definite mark on the nature of the varieties. Thus, the wheat of the rivet type (T. turgidum), grown from time immemorial in England and the mountain areas of Germany, Italy and Spain, is a most productive type characterized by a low-quality flour, and at the present time is used to feed birds and produce biscuits. The cultivation of one-grained (T. monococcum) types, which is practiced to a considerable extent up to the present day in the hinterland of Spain (up to 40,000 hectares) and in Bavaria (Figure 35), is due to its use for feeding pigs.

* E.N. Sinskaya, Forms of gold-of-pleasure (Camelina sativa) in their relationship to climate, flax and man. Proklad, Botan. Genet. i Selektiv. Works in Applied Botany, Genetics and Selection), Vol XXV, No 2, 1930-1931, pp 98-200.

The fact that in the Mediterranean countries the Arabs grow chiefly large-kernel hard wheat is due to the fact that the grain is used instead of rice for the preparation of a fermentation product, the so-called kous-kous. After threshing, the dried grain of the hard wheat is soaked for one or two days and then subjected to fermentation, after which it is dried and passes to the consumer in this form. The development of towns of the European type, and industrial centers in Morocco, Tunisia and Algeria, and the increased consumption of white bread as the result of this have led to the hard wheat being replaced by soft. At the present time, the wonderful hard wheats of Mediterranean countries are being supplanted by soft wheat, which is spreading deep into Morocco, Tunisia and Algeria; it is mainly used by the native population for kous-kous and macaroni.

The invention of rolling mills in Hungary in the '70s of the last century, led to a decisive change-over to the cultivation of soft winter wheat which has a hyaloid kernel of the Banat area type in the steppe areas of Europe and America. The new demands made by the bread-baking industry for an increased percentage of proteins in the wheat of Canada and the U.S.A. made it necessary to direct selection towards varieties most rich in proteins. The use of bromates for the amelioration of the quality of the flour, as now widely practised in Western Europe and America, will undoubtedly bring about new changes in grain standards and correspondingly in selection.

The beer industry also presents great demands on the quality of barley, desiring a large grain, smoothness, fineness of pellicle, uniformity of germination, and quality and quantity of extractives.

The canning industry in America, England and France put forward special demands on the varieties of peas and string beans for a uniform size, given chemical composition and certain color properties.

Such industrial crops as cotton, flax and hemp are very strongly influenced by industrial requirements. In growing different varieties, the selection expert must take into account the demands of the market, including the prejudices, habits and caprices of the consumer. Thus, for instance, the European and American markets avoid varieties of oats with dark-colored bracts, although this feature has no connection whatsoever with the food qualities or nutritional value of the oats. Europe, the largest lentil market in the world, absolutely insists on lentils of a green color.

The presence of yellow pigmentation in wheat grain is considered by American millers as a serious defect, a fact which led to the rejection of the valuable Marquillo inter-species hybrid variety, developed at the Minnesota Experimental Station.

While the population of Southwest Asia consumes large quantities of leguminous crops--peas, lentils, chick-peas, beans and grass peas of the most varied colors, including black, as occurs especially in Northwest India and Afghanistan. Countries located on the shores of the Mediterranean Sea cultivate predominantly light-colored forms of seed, while black-seed varieties enjoy not the slightest demand.

The milling industry attributes great importance to the form of the grain, as this is connected with the flour yield. One of the characteristic features of the standard Canadian variety of spring wheat, Marquis, is the keglike shape of the grain, making it easy to distinguish it from other varieties and in addition making for a high flour yield.



Japan. Island of Hokkaido, the most perfected method of drying rice on wooden poles



Japan. Drying wreaths of rice on the island of Hokkaido. The man in the harvested field is N.I. Vavilov



Japan. Island of Hokkaido. Assembling stacks of rice on wooden tripods



Japan. Shizuoka. Tea plantation

Biochemical properties—the percentage of proteins and oil and the quality of the oil—are acquiring an ever-greater importance in selection, in accordance with the demands made by industry. In evaluating varieties, we must pay sufficient attention to all these complex factors of economic significance. In studying the world assortment of varieties and the various features of the composition, we must take all possible account of economic factors and even bear in mind the instability of the criteria of the standards themselves.

Variability of Characters

In proceeding to a study of ecotypes of varieties and an agroecological classification of the world assortment of cultivated plants, we must take into consideration the variability of features influenced by external conditions. Under extreme conditions variations in the phenotype are manifested particularly sharply. A variety may change till it is no longer recognizable. G. Azzi*, in his interesting treatise on agricultural ecology (1939), describes astonishing differences of one and the same variety, depending on external conditions. Thus, in the agricultural museum at Perugia, Azzi tells us, we may see a remarkable wheat plant with 342 large clusters of wheat. The number of grains in this plant was close to 7,000, but even this is not the maximum.

Conversely, under unfavorable conditions in Azzi's experiments, the wheat rather resembled forage grain, having a single spike with but a single grain. The difference in all the plants in this particular case was expressed in the ratio of 1:50,000. The number of grains of the poorly developed plant, in comparison to the number of grains of the giant plant, was expressed by the ratio of 1:7,000. It is interesting that the single grain was nevertheless comparatively large and fully capable of germination. These differences show the very great degree of variability and thus the degree of adaptability of the plant to the surrounding environment.

76 In England, Professor Percival carried out experiments in which he introduced nitrogen fertilizers into the soil five times (niter or ammonium sulfate). He thus converted the grain of the English wheat T. turgidum into a hyaloid form distinguishable with difficulty from the grain of normal wheat, as regards both consistency and form. The amount of protein in wheat, barley and oats depends greatly on climatic conditions and rainfall, which reveals a certain order according to the weather changes.

The quality of flax oil, the so-called iodine number, varies in dependence on the climatic conditions and the amount of rainfall.

Winter forms of wheat, rye, and barley may be sown in spring instead of autumn after undergoing yarovization.

Experiments carried out by Kostyuchenko and Zarubailo** have shown that during the cold days before the harvest in the far north, yarovization takes place on the stalk in maturing seeds, and in this manner winter forms may be converted on the stalk into spring ones and produce ears the following year after spring sowing.

* G. Azzi, Trattato di Ecologia Agraria. 1939.

* * J.A. Kostyuchenko and T.Ia. Zarubailo. Natural yarovization of grain on plants during maturation. Sost. Rastenievogstvo (Socialist Plant Breeding), 1936, No 17, pp 17-23.

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

The influence of photo-periodicity upon the varieties sometimes manifests itself in a surprising manner. Our geographical experiments showed a sharp increase in the height and foliation of plants, as we moved north within the boundaries of the European part of the Soviet Union. It is essential to consider the influence of environmental conditions on phenotype changes from all points of view.

Nevertheless, factual data obtained from the study of world ecotypes of different crops which we sowed under different conditions, beginning with the near polar region ($67^{\circ} 44'$) and ending with the Transcaucasia, Central Asia, and the Far East, have shown on the whole the perseverance of ecotypes, expressed particularly sharply when a comparative study is made of varieties sown alongside each other. As a rule we had no difficulty in differentiating definite ecotypes under the usual more or less normal conditions. Under normal conditions of cultivation in any part of the USSR whatsoever, northern long-fiber flaxes, when planted in the spring and compared with southern varieties—intermediate fiber and curly types — differed markedly in height and slight branchiness. We had no difficulty in distinguishing between characteristic curly long-fibered and intermediate forms of flax, in Saratov, Kuban, Transcaucasia, Central Asia, near Moscow and Leningrad, or beyond the Arctic Circle. The large-seed, large-flower and large-boll varieties of Mediterranean flaxes, as well as the small-seed, small-boll flaxes, remained the same under the most varied conditions. As shown by direct experiments and observations carried out over many years, the distinct ecotype properties of the crops we studied manifested themselves graphically under field conditions everywhere in the USSR from the far south to the far north. The property of a clear group immunity to different types of rust and powdery mildew was manifested with astonishing constancy under various conditions of normal field cultivation*.

In studying varieties under field conditions in our voyages in many lands and throughout the Soviet Union, we had the possibility of convincing ourselves a number of times, of comparative endurance of definite ecological-geographical types.

In this respect, the comparative method of study of various forms planted under similar conditions is just as decisive as the study of the behavior of various ecotypes under different conditions. Concrete, factual experimental data makes it possible to differentiate with confidence the vast assortment of existing forms. This is also the conclusion reached after research into wild species of plants. (G. Turesson** and E. N. Sinskaya***).

Range and Distribution of Agroecological Groups

The agroecological groups into which we divide the world's resources of the crop varieties studied are distinguished by varying extensiveness and location. Sometimes they embrace a large variety of forms distinguishable according

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- * N.I. Vavilov, Immunity of Plants to Infectious Diseases. Moscow, 1919; N.I. Vavilov, Theory of the Immunity of Plants to Infectious Diseases. Leningrad, 1935.
 - ** G. Turesson, Rassenökologie und Pflanzengeographie. Botaniska Notiser H. 3-4, 1936, pp 420-437.
 - *** E. N. Sinskaya, Species Formation in Lucernes and Other Plants. Prilozh. 73e k Tr. po Prikladn Botan, Genet. i Selekt. (The 73rd Supplement to Works on Applied Botany, Genetics and Selection), 1935



Japan. Harvesting long white radish
on the island of Hokkaido



Japan. Harvesting of another variety of
long white radish on the island of Hokkaido



Brazil. Hand cultivation of rice clusters in the State of Sao Paulo



Brazil. Transportation of sugar cane

to morphological and even physiological properties. Thus, for instance, the wheats and barleys of Ethiopia represent a definite ecologico-geographic entity, and at the same time display a surprising variety of morphological features. In this particular respect the ecological type corresponds essentially to a complex species which is morphologically well-developed. The wheats and barleys of Ethiopia, characterized by a distinctly expressed unity of vegetative features, growth period and general appearance, yet have pronounced differences in spike-form and color, color of beards and kernels, and compactness of the head; barleys are represented both by two-row and six-row hulled and naked-grain forms, with developed and undeveloped lateral ears. Nevertheless, they represent a single ecotype which we have grouped into a special subspecies of cultivated Ethiopian barley.

Chinese wheats, which we classified into a special agroecological group, revealed a very great variety, determined by hundreds of different sorts that may be distinguished on the basis of compactness of head and degree of beard-ness, color of ear and grain, winter and spring mode of life, and immunity to brown and yellow rust. Nevertheless, there is a definite unity in all this variety, appearing when a comparison is made with other groups. In going to the field and observing the Chinese group of wheats under various conditions in the south and north, in the forest, forest-steppe, and steppe zones, in the Transcaucasus and Central Asia, we can entertain no doubts whatsoever that there is something unique about them. This is manifested by the stunted height, swift maturation, small grain size, multi-flowered heads, and the presence of special features, for example, the complete absence of beards, high degree of density of heads, peculiar only to Chinese wheats, the display of a large number of forms immune to brown and yellow rust, and accelerated grain ripening. In fact, we may speak of a Chinese subspecies of soft wheats, or even of a separate species. The steppe group of winter wheats embraces a considerable number of native and selected varieties, such as Kooperatorka, Ukrainka, Stepniachka, Krimka, and many others. These varieties are known to be distinguished by a varying degree of resistance to winter conditions, a fact which must be taken well into consideration when planning the dissemination of specific varieties. In reviewing the world resources, these varieties stand out so much by virtue of their common physiological and morphological properties that we are perfectly entitled to group them into a special steppe agroecological group. In its turn, each specific agroecological group may if necessary be subdivided into subgroups, varieties, and so forth, which is exactly what we did in respect to the crops being studied.

As in the species, certain agroecological groups represent a comparatively narrow range of differences, being natives of a limited territory in their original growth areas. Such are *Triticum timopheevi*, *T. macha*, and *T. vavilovii* (Thum.) Jakubz. In this particular case the species is represented morphologically and physiologically as a single and highly limited agroecological group. The dimensions of both species and agroecological groups are different, as determined by the history of their development, their location, and their specific properties, the nature of which is so far insufficiently known to us.

The basis of the above classification of cereals, leguminous crops and flax is the factual material studied from all points of view under various conditions and representing a first attempt at grouping the world resources of varieties into a harmonious evolutionary system, taking account of the history of the development of the crops, their distribution, and the environmental conditions under which they develop. There is no doubt that there will later be need of a more detailed work for separate groups, countries and even regions. The capacity of research workers to learn grows just as do the demands made upon the varieties. Elaboration of methods of study of the biochemistry and physiology of various types will undoubtedly open new vistas in the future.

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX
List of the Main Characters and Properties Considered in the Elaboration of an
Agroecological Classification Adapted to Annual Cereals,
Leguminous Seed Crops, and Flax

Habit of Plant

1. Height of plant
2. Dimensions of leaves and foliage
3. Branching (bushiness)
4. Character, thickness and erectness (degree of bending of stalks and density of pith)
5. Size of ears (fruits)
6. Character of ear (fruits): coarse beards, beardlessness; degree of splitting of fruits; nature of threshing properties
7. Size of seeds
8. Degree of seed-shedding

Growing Period

9. Life habit: spring, winter, semi-winter
10. Length of growth period (under definite conditions)
11. Duration of period of yarovization in winter types
12. Absence or presence (duration) of yarovization stage in spring types
13. Reaction to shortened day (photoperiodism)
14. Rate of development
15. Rapidty of grain ripening
26. Post-harvest maturation (tendency of seeds to germinate in the head)

81

Other Biological and Physiological Properties

17. Resistance to drought at different stages of development, considering both soil and atmospheric drought (hydrophytic, xerophytic, mesophytic)
18. Resistance to low temperatures at different stages of development
19. Resistance to winter conditions (with reference to excessive and insufficient moisture conditions)
20. Productivity under optimal conditions of growth

Immunity to Infectious Diseases and Resistance to Insect Injuries:

21. Resistance to fungal and parasitic diseases peculiar to the particular crops.
22. Resistance to bacterial diseases
23. Vulnerability to insects peculiar to particular crops.

Technological Properties

24. Color of grain
25. Morphology of grain
26. Degree of boiling of grain necessary to form pulp
27. Qualitative and quantitative chemical composition
28. Flour yield at milling
29. Quality and quantity of fibre, etc

MODERN GEOGRAPHY OF CEREALS, LEGUMINOUS SEED-CROPS AND FLAX

The annual global area under cultivation with domesticated plants today is estimated to be approximately 850 millions of hectares, which is less than 7% of the total dry land area. Large areas of Africa and South America have so far not been utilized for agriculture, despite the complete feasibility of developing there the most valuable tropical and subtropical crops. Until now, the principal concentrations of agricultural produce have coincided with the most ancient crop areas, particularly Southeastern Asia and the shores of the Mediterranean. The most exploited continent for agricultural purposes is Europe. Considerable areas are taken up by agriculture in Western Siberia and in the western areas of North America. In South America, agriculture is concentrated principally in Argentina and the western slopes of the Cordillera range. Of the islands, those most utilized for agriculture include England, the islands of the Mediterranean Sea and islands in Southern Asia, Indonesia, Philippines, Central and Southern Japan. In the Australasian continent, agriculture is concentrated in the huge areas of the southwestern and southeastern parts. Our own broad Asiatic North has until now been used little for agriculture. The important moves in this direction characterize only the Soviet epoch*.

The total area under crops mentioned above is distributed among the individual cultures** in the following manner:

	<u>Millions of hectares</u>
Under wheat	Nearly 160
" oats	" 55
" rye	" 40
" barley	" 37
" leguminous seed crops (including soya and peanuts)	" 47
" chick peas	" 9 (mainly in India)
" peas	" 3.5 "
" beans	" 2.3 "
" lentils	" 2.1 (various species)
" flax	" 11

For other crops, we note the following areas:

Under corn	Nearly 85
" rice	" 78
" cotton	" 33

* See the map of world agriculture in "The Large Soviet Atlas of the World", Vol I, compiled by I.F. Makarov, under the editorship of N.I. Vavilov.

** International Year Book of Agricultural Statistics. 1938-1939.



Peru. Peasant woman from Cusco
Province



Brazil. Coffee plantations in Sao Paulo State



Peru. Inhabitants of one of the towns



Brazil. Coffee plantations in Sao Paulo State

Under hemp	Nearly 20 millions of hectares
" vegetables and melons	" 13 " " "
" fruit (including grapes and olives)	" 27 " " "

In the present work, we have considered the group of true cereals: wheat, oats, barley, rye; the leguminous seed crops: peas, lentils, beans, chick-peas, grass peas, and finally the fibrous and oil-producing plants: flax. All these crops, despite the fact that they belong to different botanical families, exhibit many common ecological-geographic traits. In the process of evolution and differentiation, they were disseminated from Anterior Asia (Asia Minor, the native land of the majority of crops of the group examined). As a whole, these plants are suited for cultivation in a temperate climate. In the tropics they are usually grown in mountainous areas which are also characterized by a moderate climate. The total area under crops examined exceeds 300,000,000 hectares. Within the borders of the Soviet Union in recent years (1939-1940), the following areas were recorded:

<u>Crops</u>	<u>Millions of hectares</u>
Wheat	Nearly 40
Oats	" 17.5
Rye	" 23
Barley	" 8.5
Lentils	" 1
Peas	" 2
Flax	" 2
Sown vetch.	" 3.5
Total:	Over 97

This area corresponds to two-thirds of the entire area taken up by cultivated plants in the USSR—nearly 140,000,000 hectares, together with gardens, vineyards, and artificial forest plantations. All of the great area occupied by the above agricultural plants is distributed today among the six continents and for convenience of examination may be divided into different agro-ecological regions and areas. The latter are characterized by a considerable degree of uniformity of both climatic and soil conditions and by definite ecological types. Naturally, in a world review we cannot dwell on details which are often by themselves highly important.

In a number of cases, more detailed reviews should be compiled, which it should be noted is indeed being done for individual countries.*

By agroecological regions, we mean large areas related by a uniformity of climatic conditions and types of crops. By areas, we mean comparatively limited territories. In this case "areas" may be part of regions, but may also be considered separately - apart from the regions—in those cases where in comparatively limited territories, for example in the Caucasus, we observe contrasting conditions and correspondingly a variety of ecotypes associated with a relatively limited territory. The basis of the classification of agroecological regions taken by us as the historical-geographical data of the distribution of the crops considered, and their geographical and ecological differentiation, taking into account the peculiarities of the agriculture of the different regions. We begin the examination of a region from the focal point of the origin of particular

* See M. Gokgol, "Wheats of Turkey", Ankara, 1939 (Mirza Gokgol, Turkeye, bugdaylary, Ankara).

86. plants and of their introduction into cultivation. Ancient areas of growth of agricultural plants, as we shall see later, are often of exceptional interest, displaying the results of thousand of years of deliberate or unconscious selection and usually possessing an enormous variety and species, potential of great interest for use in practical selection. Despite the possibility of disappearance of individual evolutionary links and even of whole species of plants in the course of a thousand years of cultivation, all the accumulation of data on the composition of modern species and varieties, and the distribution of cultured plants and related wild parents makes it possible to fix the initial regions of origin of the most important cultivated crops with a great degree of certainty.

The establishment of the initial foci of cultivation is a complicated matter for plants differentiated into a large number of genetically sharply demarcated species. This is true, for instance, of wheat and oats, whose species differ in the number of chromosomes and by difficulty in cross-breeding. In contrast to other plants not differentiated into various species, for example cultivated oats or many cultivated leguminous plants, the geographical evolution may be followed in detail. In the initial developmental regions, we may often trace the genetic connections of the cultivated forms to the wild species to this day. For a number of plants in these same original regions, the ancestral potential of the plant in question remains concentrated, i.e., a maximal number of cultivated and wild species of the particular family and families closest to it.

Our research into the evolution of cultivated plants has led us to conclude that many species of cultivated plants and wild parents nearest them did not go beyond the borders of their basic centers of origin. As a rule, in the basic centers, we meet with more varied species of both the cultivated and especially the wild parents closest to them. This may be illustrated graphically by the example of wheat, rye, peas, lentils and grass peas. Without dwelling on each plant separately, we note that, as a whole, such crops as wheat, oats, rye, barley, flax, peas, lentils, chick peas and grass peas basically arose and were introduced into cultivation in Asia Minor and the adjacent areas in the Caucasus, Central Asia, Northwest India, mountain areas of East Africa, and countries located on the shores of the Mediterranean. It was from here, together with man and by his will, that these crops became distributed throughout continents of the Old and New Worlds. The beginnings of agriculture have been established by documents as occurring in Asia Minor and Egypt 6,000 years before our era. As far as the antiquity of agriculture is concerned, these areas are followed closely by the areas of Central Asia, the Apennines, Pyrenees, Balkan Peninsulas, and the islands of Crete, Cyprus, and Sicily. There is no doubt whatsoever that the agriculture of the mountain areas of East Africa (Ethiopia and Eritrea) also go back thousands of years, as attested by the presence there of endemic species and even families of cultivated plants and of a unique agro-technique. The above territory was the base where we fixed the beginnings of the cultivation of plants considered by us. Barley, wheat, flax, and leguminous seed crops, as established by archeological research, are among the most ancient plants of the world. Later on, land cultivation developed in the territory of the European plain, but here also the beginnings go back thousands of years. The most ancient remains of wheat culture in England date back to 2,000 years before our era. According to the data of Greek and Roman geographers, spinning flax was exported from Eastern Europe some centuries before our era. Agriculture in China and India is not less than 5,000 years old.

The Old World territories mentioned above are, as shown by our researches (All-Union Institute of Plant Breeding), the most probable birthplace of the majority of species of cultivated plants considered and the site of their initial

87 introduction into cultivation*. Here we may follow the initial evolution of the majority of cultivated plants examined and in many cases establish the direct connections with the original wild forms. From these areas, agriculture spread comparatively slowly before the discovery of America and the general period of great geographical discoveries in the 15th, 16th and 17th centuries. Even the broad areas of the Northern Caucasus and the Kuban characterized by fertile and deep chernozems began to be widely used only in the second half of the 19th century, and even in the 70's of the last century the entire area under cultivated plants in the Northern Caucasus amounted to a few tens of thousands of hectares, while at present in the Krasnodar, Stavropol, and Rostov regions it has reached 15,000,000 hectares.

The widespread development of agriculture in North America in the territory of what is now the USA, Canada, and Northern Mexico, in South America, in what is now Argentina, Brazil, Uruguay, and Chile, and in Australia and South Africa, dates from the second half of the 18th century, but belongs essentially to the 19th century. The maximum expansion of areas under crops throughout the world occurred in the second half of the 19th century, to prove which, it is sufficient to point to the expansion of areas sown with wheat in Canada, where in the course of the last 30 years, the area has increased from 1,000,000 to 11,000,000. The increase in sown land in North Africa also dates from the last few decades. The cultivated territory of Argentina, which in recent years has totalled 28,000,000, resulted from recent development associated chiefly with the wide application of mechanization.

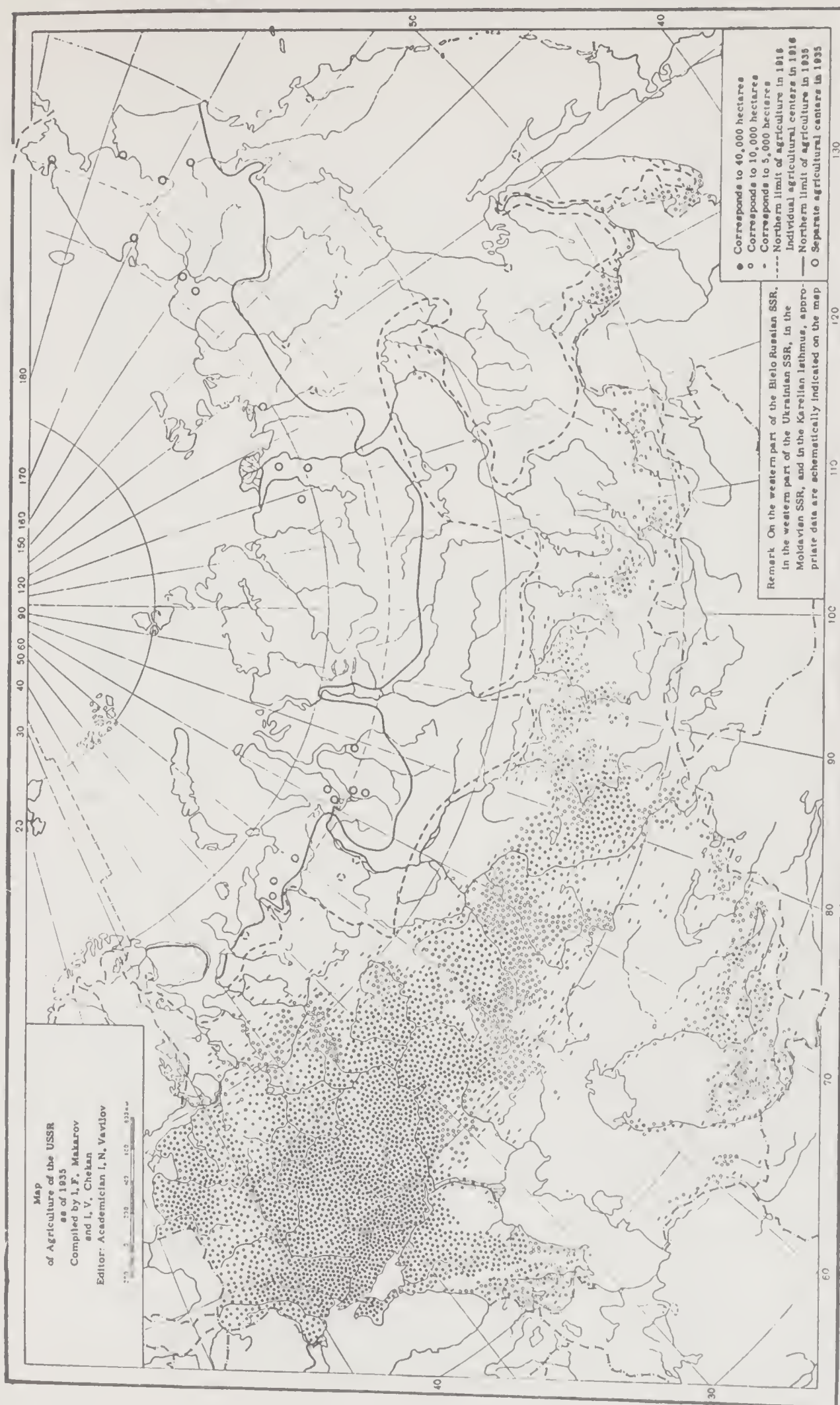
As may be seen from the appended map showing the locations of cereals, leguminous seed crops and flax, the main sown areas are today concentrated in Central and Southern Europe, Asia Minor, Western Siberia, India, Eastern China, Central and Eastern areas of the USA, Southern Canada, Argentina, North Africa, and Southern Australia. At the beginning of the 19th century the basic zones of the above cultures were still concentrated chiefly in the Old World, in Central and Southern Europe, on the shores of the Mediterranean and in Asia Minor, India and China.

We shall examine the agroecological regions and areas as far as possible in the evolutionary order, in the historical sequence of development.

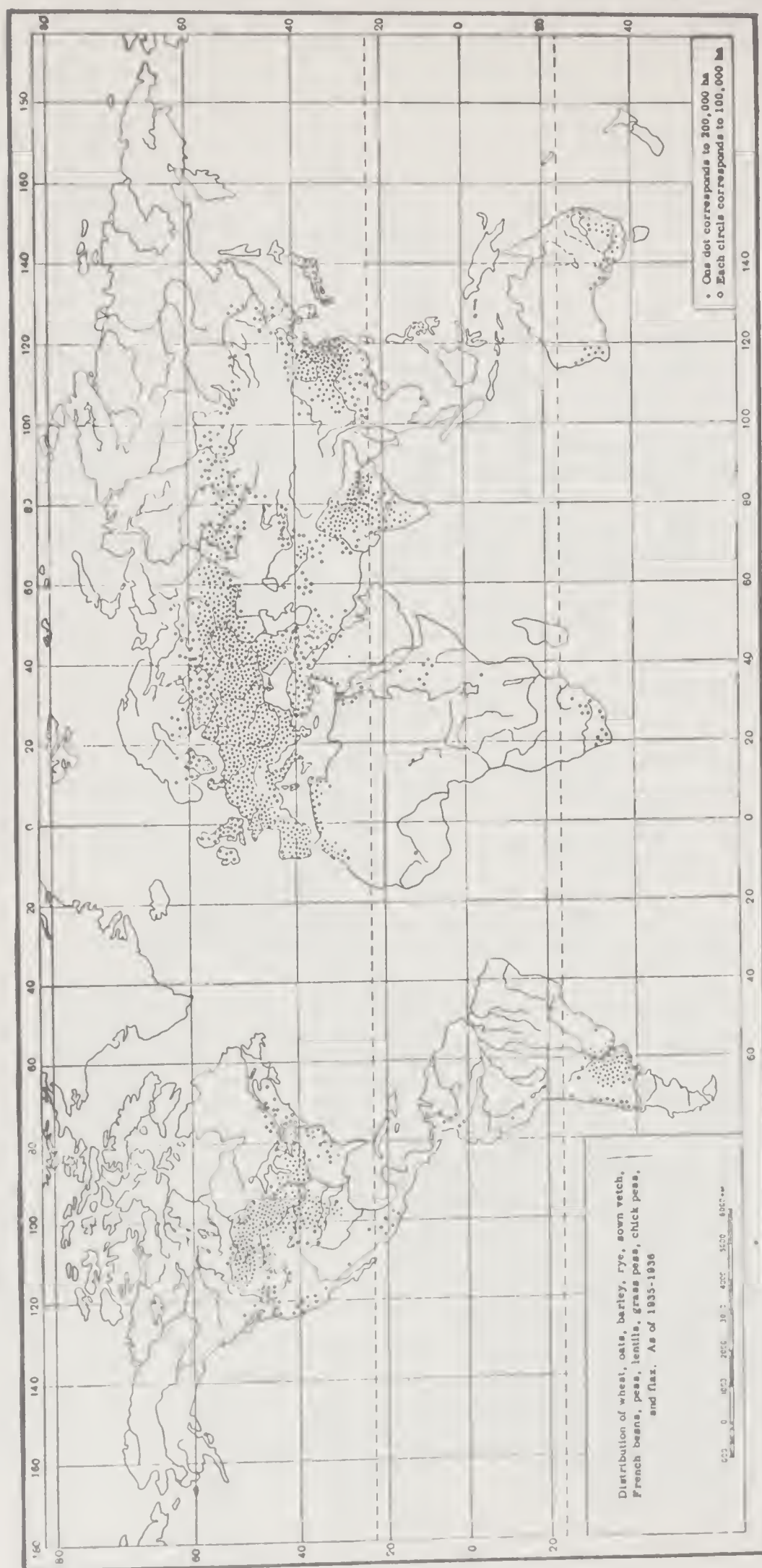
88 In the first place, we shall examine, from the point of view of these particular crops, the most ancient cultivated areas, concentrated in the Caucasus and Southwestern Asia, on the shores of the Mediterranean, and in the mountain areas of East Africa; the Transcaucasia and Daghestan, and also the Central-Asiatic Soviet Republics, stand out globally for the number of original species of wheat, of agroecological groups of wheat, barley, and leguminous seed crops, and rich variety of different species. A large number of wild species are concentrated here, the closest parents of the cultivated crops in question. Immediately following this, we go on to examine the southern and northern lands of Europe and Western and Eastern Siberia. We later go on to a consideration of the agroecological regions of the New World, Australia and South Africa, the differentiation of which occurred very recently chiefly in the 19th century.

In comparing the characteristics of individual agroecological regions and areas, we use the results of the concrete study of the cultivated plants in

* N.I. Vavilov, Theory of the Origin of Cultivated Plants According to Darwin, Sov. Nauk. (Soviet Science), 1940, No. 2.



Map 1. Agricultural areas of the USSR as of 1935 (cultivated area without fallow land, including gardens and vineyards)



Map 2. World areas sown with wheat, rye, oats, barley, peas, lentils, chick peas, beans, grass peas, vetch, and flax, as of 1935-1936

various countries during expeditions we have organized and of the agrobotanical study of varieties collected in these regions and areas by means of comparative sowing. In drawing up the characteristics of regions, we give, as far as possible, the typical climatic and soil features. Soil descriptions are given on the basis of the world map of soils prepared by Academician L.I. Prasolov*, climatic data were taken mainly from the reports in "Handbuch der Klimatologie", edited by Koppen, Graz, and Geiger, and the "World Agroclimatic Reference Book", ed. by Prof. G.T. Selyaninov (Leningrad, 1937). We also used "The Climatic Reference Book of the USSR", compiled by the Institute of Climatology, under the editorship of A.A. Kaminskii and E.S. Rubinshtein (Leningrad, 1932). For certain countries these data were supplemented by other sources. In drawing up the description of the selection value of varieties of the individual agroecological groups we took into consideration the results of the State Variety Proving Service, as well as the behavior of varieties in geographical experiments conducted by us at 125 points of the Soviet Union during 1923-1935.

The Italian ecologist, G. Azzi**, began the study of the ecology of wheat on a global scale. His book, "The Climate of Wheat throughout the Globe", represents the first attempt at an approach to a detailed agroecological study of the different territories of the world. He dwells chiefly on the consideration of the climatic conditions under which wheats grow, pointing out which factors act positively and which negatively on the growth of wheat in the various areas of the world. Our attention was directed chiefly to an evaluation of the assortment of varieties peculiar to the different agricultural areas which evolved as a result of the action of external conditions of natural and artificial selection. The final aim of our research was to reveal the selection value of the variety of material of different regions with the aim of applying these findings in various areas of the USSR. While Azzi, as a meteorologist and ecologist, directed his attention above all to the climatic conditions, particularly the specific conditions, both negative and positive, acting on the growth of wheat, in our research the problems of selection compelled us to direct our attention chiefly to plants and varieties, taking into account in this respect the specific peculiarities of the environment, including the agricultural conditions under which the particular species and varieties had evolved. Our task included discovering the range of variety difference in the crops studied, regarded as a complex, together with the environment and activity of man. The agroecological regions and areas we established show the conditions under which the individual ecotypes evolved. We strove to orientate the selector in the choice of the material he needs and in finding definite valuable inheritable properties.

We present below an enumeration of our agroecological regions of the globe in respect to the crops we examined. The direct study of varieties and conditions of culture compelled us to depart from the usual framework of administrative divisions. We were, in fact, compelled to begin with such divisions. However, further study forced us to adopt not the chance administrative borders, with all their arbitrariness and lack of constancy, but more definite natural and comparatively permanent ecological boundaries, determined by climate, soil, and the agricultural activity of man. The agroecological analysis of the main cultural plants and the consideration of the world assortment of varieties sums up the results of world selection as expressed practically, i.e., by types and a range of variety differences, thus marking a path for further work by the plant breeder.

* See "Large Soviet Atlas of the World", Vol I.

** G. Azzi, "Le Climat Du Blé Dans Le Monde", Les Bases Ecologiques De La Culture Mondiale Du Blé, Rome, l'Institut International D'Agriculture, 1930.

List of the Agroecological Districts and Regions of the World
(Adapted to Cultivated Plants of the Temperate Zone)

Hither Asia (Southwestern Asia in the broad geographical sense)

1. Syrian-Palestine inland mountain dry region, including Transjordan.
2. Asia Minor interior highland region.
3. Prepontic Moist Subtropical Region of Asia Minor, including the adjacent territories of Abkhazia and Adzharia.

Caucasus (in a broad geographical sense)

4. Western Georgia, moist mountainous region (Racha-Lechkhumi) and the adjacent areas.
5. Georgian and Azerbaijan comparatively dry mountain steppe areas, region from Suram chain to the areas of Nukhi and Shemakhi, located at 450-1,500 meters above sea level (southern slope of the main Caucasus chain). Crops are frequently irrigated here.
6. High mountains (over 1,500 meters above sea level), sufficiently moist steppe areas of Armenia, Georgia, and Daghestan.
7. Zakataly moist region (including the Alazan Valley), characterized by a mild, almost sub-tropical climate.
8. Armenian dry uplands, where cultivation is usually irrigated. This includes the Yerevan area and the southern slopes of the Alagez and Dar Alagez chain.
9. Karabakh Upland Region (agriculture without irrigation).
10. Nakhichevan irrigated Region (near Arax river).
11. Caspian (insufficiently moist) region. (Foothill and low-lying areas of Eastern Daghestan and Azerbaijan).
12. Apsheron semi-desert region.
- 90 13. Talysh moist sub-tropical agroecological area (including Lenkoran and Astara areas and the Astrabad, Mazanderan and Ghilan provinces of Northern Iran).
14. Zuvand (near Iran) mountain area north of Lenkoran.
15. Foothill and mountainous moist areas of Northern Caucasus.

Central Asia (in a broad geographical sense)

16. Iran-Turkestan agroecological region. This includes the interior areas of Iran, Uzbekistan, Turkmenistan and Tadzhikistan mountain and foothill areas of Kazakhstan, Karakalpakia, Kirgizia, and Sinkiang.
- 16a.- Mountain and foothill regions of dry-lands with a sufficient water supply with predominance of unirrigated cultivation.
- 16b.- Foothill and mountainous regions of dry-lands with insufficient water supply.
- 16c.- Foothill and mountain areas with irrigated crops.
- 16d.- Khiva Oasis (lower reaches of the Amu-Dari, with irrigated agriculture.)
- 16e - Sinkiang oases of Western China (Kashgar, Yarkand, Khotan, Uch-Turfan, etc).
17. Kabul. Agroecological region (comprising the oasis of Kabul and adjacent agricultural areas).
18. High mountain Central Asian agroecological region.
- 18a.- High mountain agricultural areas of Hindu-Kush, and the Hissar, Turkestan, Alai, and Tras-Alai ranges.
- 18b.- Pamir-Badakhshan high mountain agricultural region.
- 18c.- High mountain agricultural regions of the Himalayas.
- 18d.- Agricultural oasis of Tibet.

19. Agricultural areas of Northwest Tian-Shan (foothill and mountain areas of Kirgizia and Kazakhstan, including the areas of Tibet and the northern slopes of the Himalayas).

India and Pakistan

20. Southern mountain slopes of the Western Himalayas, including Kashmir and the elevated areas of the Northwest.
21. Northwest arid low lying areas of India including Punjab, the North West frontier province, Peshawar, Sind, and the western part of Rajasthan.
22. Central India.
23. Baluchistan mountain agroecological region.

Arabia

24. Mountainous Arabian agroecological region (the Yemen).

Ethiopia and Eritrea

25. Ethiopian agroecological area, including the high mountain agricultural areas of Ethiopia and Eritrea.

Mediterranean Countries

26. True Mediterranean agroecological region, comprising the coastal low-lying and foothill areas with mild subtropical climate, the rainfall occurring mainly in autumn and early spring.
- 91 27. Mountainous areas of North Africa (Atlas Mountains, Kabylia, Riff mountains in Morocco).
28. Mountainous areas of the islands of Cyprus and Crete.
29. Egyptian agroecological regions, including the Upper and Lower Egypt Regions and the Sudan.
30. Aegean agroecological region (the Aegean Islands and the adjacent areas of Asia Minor and Southeastern Greece).
31. Interior oases of Syria, Morocco and Algeria.

Eastern Asia (in the broad geographical sense)

32. Chinese-Japanese agroecological region (in a broad sense)
- 32a. Northern agroecological areas of China (a large part of the provinces of Kansu, Shensi, Shansi and adjacent provinces of Inner Mongolia).
- 32b. Central China (Honan and the adjacent provinces along the River Wei-ho).
- 32c. Areas of the Great Chinese plain (Hopeh, Shantung, Kiangsu).
- 32d. Area of the Red Basin, Szechwan, adjacent on the west to Tibet and on the north to the Tsinling range. The whole province is located on the middle reaches of the Blue River (Yangtse).
- 32e. Areas of Southern China (the provinces of Yunnan, Kweichow, and Anhwei).
- 32f. Areas of Southeastern China.
- 32g. Agricultural areas of Korea.
- 32h. Agricultural areas of Japan.
33. Mongolian agroecological region.
34. Northeastern China agroecological region.
- 34a. Heilungkiang and Kirin (Northern Manchuria) Region.
- 34b. Liaotung (Southern Manchuria).

Southern Europe (in the broad geographical sense)

35. Agricultural areas of interior Spain.
36. Portuguese agroecological region.
37. Southern French agroecological region, including the valley of the river Rhone.

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

38. Interior Italian agroecological region.
- 38a. - Lombardy area.
- 38b. - Mountainous areas of Italy.
39. Agricultural areas of Northeastern Greece and Macedonia, including the Calley of Thessaly and Macedonia, along the River Vardar, the European part of Turkey, and the valley of the Maritza river in Bulgaria, with its tributaries.
40. Balkan mountain agroecological region, including the mountainous areas of Greece, Albania, Southern and Central Yugoslavia and Bulgaria.

Mountain Areas of Western and Central Europe

41. Area of the Pyrenees, including the Cantabrian mountain area, the Asturias Galician and Basque provinces.
42. Alpine-Tyrol region, including the agricultural areas of Switzerland, Italian Alps and mountainous parts of Austria.
- 92 43. Carpathian area, the Carpathian Crescent
44. Southern upland areas of Germany, including Bavaria, Wuerttemberg, Baden, Saxony and Thuringia.
45. Czechoslovak Highland areas, including the spurs of the Western Carpathians.

Northwestern Europe (in the broad geographical sense)

46. Northwest French low-lying agroecological region, including Belgium.
47. Northern low-lying German agroecological region.
48. The Baltic agroecological region, including northern Poland, Kaliningrad region of the RSFSR, Lithuanian SSR, Latvian SSR, Estonian SSR, and the south central part of Finland.
49. Maritime Western European agroecological region, including the low-lying parts of Great Britain, Ireland, Holland, Denmark, the southern coast of Sweden, and the southern low-lying narrow coastal zone of Norway.
50. The Scandinavian agroecological region, including the interior areas of Sweden, Norway and Finland.

The European Steppe Agroecological Region (in a broad geographical sense)

51. Hungarian steppe, including its bordering foothill areas, and the Banat.
52. Danubian Steppe, including low-lying parts of Rumania and northern Bulgaria (Great Walachian Plain).
53. Steppe parts of the Ukraine, including Moldavia and the Crimean steppes.
54. The Northern Caucasus steppe.
55. The Volga steppe.

Eastern European Forest-Steppe Agroecological Region (in a broad geographical sense)

56. Western Forest Steppe region of the European part of the USSR.
57. Eastern Forest-Steppe Region of the European part of the USSR.

Eastern Europe Forest region (in a broad geographical sense)

58. Forest region of Poland.
59. Western non-chernozem region of the European part of the USSR (with predominance of winter agriculture).

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

60. Eastern non-chernozem region of the European part of the USSR (pre-dominantly spring agriculture).

Siberia

61. Western Siberia steppe region.
62. Western Siberia forest-steppe region.
63. Western Siberia taiga region.
64. Altai-Sayan agricultural areas.
65. Eastern Siberia agroecological region.
66. Trans-Baikal (Buryat-Mongolian) agroecological region.
93 67. Yakutian agroecological region.
68. Amur River agroecological region.
69. Far Eastern Maritime agroecological region.
70. Sub-Polar agroecological region of Eurasia (above 62° North latitude).

North America

71. Western forest agroecological region of North America and Canada.
72. Eastern forest agroecological region of Canada (Province of Quebec).
73. Agricultural areas of Alaska.
74. Forest-steppe agroecological region of Canada.
75. Central steppe agroecological region of Canada and the USA.
76. Southeastern steppe agroecological region of the USA.
77. Illinois agroecological region.
78. Great Lakes agroecological region of the USA.
79. Region of Western Uplands of the USA (Great Basin).
80. Northwestern Coastal agroecological region of the USA.
81. Southwestern upland agroecological region of the USA.
82. Southwestern lowland agroecological region of the USA.
83. Upland Mexican agroecological region.

South America

84. Areas of the Argentine pampas, including Uruguay.
85. Western and southern periphery of the Argentine pampas.
86. Southern steppe portions of Brazil.
87. Areas of irrigated agriculture of Chile.
88. High mountain areas of Peru and Boliva.

Australia and New Zealand

89. Areas of the southern coast of Australia.
90. Steppe southeastern areas of Australia.
91. Southwestern dry areas of Australia.
92. New Zealand agroecological region.

South Africa

93. South African Coastal agroecological region.
94. Southwestern part of Cape Province.
95. Interior steppe agroecological region of South Africa.

AGROECOLOGICAL REGIONS OF ASIA, EUROPE, AND
NORTH AND EAST AFRICA

(applying to cereals, leguminous seed crops, and flax)

HITHER ASIA

Hither Asia, in the broad sense of the term, includes the Asia Minor peninsula, Syria, Palestine, Transjordan, Mesopotamia and the adjacent areas of western Iran, and represents one of the Old World's most informative territories for an understanding of the initial evolutionary stages of the main plant crops - i.e., wheat, barley, rye, many leguminous plants, flax and others. We find here an exceptionally rich concentration of species of wild and cultivated wheat, wild barley and rye, flax and leguminous seed plants. A variety of relatives of wheat, such as the numerous species of *aegilops* wild oats (*Aegilops* L.), and sources of *Haynaldia* (*Haynaldia* Schur.), are concentrated here. The most ancient documentary data concerning the history of agriculture, pertaining to the Fourth millenary B.C., are connected with Hither Asia. As is shown by archeological, historical and zoogeographical data, this territory is part of the homeland of cattle, the eastern horse and other farm animals of the Old World. Plough agriculture itself originated in this region.

On the ecological climatic map drawn by G. S. Papadakis (*Ecologie Agric.*, 1938, Hither Asian regions are classified into two zones: the zone of winter wheat and the citrus zone.

The Asia Minor peninsula, Syria and Palestine are characterized by varied ecological conditions. Papadakis schematically grouped together the climates of Inner Anatolia, the Ukraine and the Caucasus. To this we cannot agree, nor can we consider as justified his grouping together of the climates of the Aegean Islands, Southern Greece, the whole of Syria and Palestine and the southern part of Asia Minor in an "Aegean region". Nor is it correct to group in one Iranian region the humid climate of Northern Iran and of Lenkoran with the extremely arid climate of the Iran-Turkestan region.

G. Azzi* more correctly divides Asia Minor into 4 ecological regions of wheat cultivation:

- 1) A coastal zone, characterized by a typically Mediterranean climate, with a prolonged summer drought, a considerable quantity of precipitation during the winter and spring periods, and unfavorable action by dry summer winds;
- 2) A zone characterized by cold winds, including the Adana Vilayet and the Aleppo area, having a similar climate; according to Azzi, this area continues into the Adana district;
- 3) The valley of the Tigris and the Euphrates, characterized by an arid continental climate and fairly low temperatures in winter and spring, and a hot summer.

* G. Azzi, *Le climat du blé dans le monde*. Rome, 1930.



Syria. Environs of Damascus



Syria. Bazaar in Homs



Syria. Villages in the Hauran, on the
Palestine border



Syria. Peasant Arabs in village near Euphrates River

4) A region comprising districts of the mountains of Inner Anatolia, where wheat is cultivated at an altitude of 1,000 - 2,000 meters above sea level. Here, according to Azzi, the most unfavorable conditions are the spring dryness, the dry summer winds and the low winter temperatures. The nearer we approach the mountains, the more unfavorable the climatic conditions become, and the cultivation of winter wheat becomes practically impossible.

P. M. Zhukovskii distinguishes the following climates: Western Anatolia, Southern Anatolia, the Central Plateau, Eastern Anatolia and the Pontic Province. V. K. Kobelev and E. F. Pal'mova try to divide agricultural Turkey even more exactly according to the varieties of wheat. In Turkey they distinguished up to 15 ecological types of wheat*.

Gëkgël, in his work "The Wheats of Turkey", distinguishes a great number of ecological types of wheat, corresponding to a more detailed division of Turkey.

In studying the ecological and agricultural districts of Hither Asia, we should first of all differentiate low-lying and elevated coastal regions, characterized by a mild climate corresponding to the climatic conditions of the Western Mediterranean, the southern areas of Spain, the coastal areas of Algeria, Tunisia and Morocco, and the Islands of Sicily and Sardinia. We intend to examine the peculiarities of these regions more closely under the general title of the "Mediterranean Agroecological Region". To the latter, but still within the limits of Hither Asia, also belong the narrow coastal zones of Syria and Palestine and parts of southern and South-western Anatolia. With the exception of the districts belonging to the Mediterranean region, we divide Hither Asia into the following agroecological regions.

1. Syro-Palestinian inner mountainous and arid region, including Transjordan.
2. Asia minor inner mountainous region.
3. Pre-Pontic humid subtropical region of Asia Minor, including adjacent Adjaria and Abkhazia.

We shall now examine these regions, assuming them to be agricultural areas suitable for the study of cereal grains, leguminous seed plants, and flax. The variety of conditions is even greater when considering the whole country instead of only the areas where these plants are cultivated. Even within the boundaries of little Palestine, we observe striking contrasts, such as the semi-desert mountainous districts, the deep depression where the Dead Sea is situated and the arid highlands unsuited for agriculture. We will concentrate on the chief agricultural areas, as we have no possibility of describing each detail, for which a monograph on each individual country would be needed.

98 1. Syro-Palestinian Inner Mountainous and Arid Region

Areas such as the uplands of Palestine and Transjordan, the large territories of the interior Syrian heights starting from the Hauran districts directly bordering Palestine, and the northern areas of the Euphrates, where large non-irrigated wheat and barley zones are concentrated, are included in this important agroecological region. The climate of the highlands and semi-desert of Syria, Palestine, and Transjordan is characterized by drought conditions. Precipitation mainly occurs in

* P. M. Zhukovskii and others. Agricultural Turkey Leningrad, 1933 .

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX
winter, late autumn and early spring; summer is hot and droughty. Wheat is sown towards winter. The growing season is short due to the dryness of the summer. On the average, precipitation varies from 230 to 650 mm.

Precise climatologic data for a lengthy period of time are unfortunately rare for Syria and Palestine, and we must be content with a few selected and non-typical data. We quote some climatic characteristics in the following tables.

Table 2.

Precipitation (in mm) for certain places in the
Syrian-Palestine agroecological region*

Place	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Bayut-Gemal, Palestine Elev. 320 m above sea level..	104	139	26	2	21	1	0	0	0	6	54	104	457
Amman, Transjordan 31°56' North lat..	46	109	6	0	0	0	0	0	0	0	27	49	237

* Average data for two years (according to the journal "Hassadeh", 1929).

The Syro-Palestinian region is characterized by xerophyllic fast-ripening varieties, typified by low height and small number of leaves. Flax in this region is characterized by exceptional shortness and medium-sized pods. The grain leguminous plants of this region are typical (Figures 36, 40) characterized by low height and small number and narrowness of leaves. Wild wheat (T. dicoccoides Korn.) is found in considerable quantities on the stony slopes of the Hauran. A peculiar subspecies of wild wheat also accompanies cultivated hard wheat in Palestine. Wild barley (Hordeum spontaneum C. Koch., Figure 41) and wild pea, represented by a number of original species (Pisum humile Boiss. and P. fulvum Sibth. and Sm.), are found in great quantities in Syria, Palestine and Transjordan.

An interesting and original species of hard wheat, the Hauran species (T. durum subsp. horanicum Vav.), was also discovered in large quantities in the same area. It is characterized by its resistance to lodging dense, high-yield ear, and rounded grain, and proves to be one of the best wheats for the dry farming conditions in the coastal areas of Azerbaijan, as well as in the south-eastern dry areas of the Ukraine, particularly in Khersonchin (Ascania-Nova). At the edges of woods and fields and in the wastes, characteristic species of the Aegilops grow abundantly.



Palestine. Solomon's Pools



Palestine. Nomad Arabs near Hebron



Palestine, Transjordan, Jerash



Palestine. Primitive mills found in the digs at Jerash (Transjordan)

Table 3

Climatic data for certain points of the Syrian-Palestinian agroecological region*

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Hebron, Palestine, 31°31' North lat. Elev. 884m	Precipitation (mm).....	172	125	87	42	9	0	0	0	1	9	61	145	651
	Av. temp. (°C).....	6.3	8.2	9.9	14.4	18.2	20.4	22.0	22.5	21.2	19.1	13.1	4.1	14.9
Jerusalem, 31°47' North lat. Elev. 750	Precipitation (mm).....	165	127	104	40	6	0	0	0	1	10	59	146	658
	Av. temp. (°C).....	7.0	8.6	10.8	14.9	19.4	21.3	22.9	23.0	21.3	19.1	13.3	9.4	15.9
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—3.9
	Days with temperat. above 5°C.....	—	—	—	—	—	—	—	—	—	—	—	—	365
Baghdad, Iraq, 33°20' North lat. Elev. 60m	Precipitation (mm).....	33	53	40	22	6	0	0	2	0	1	26	44	227
	Av. temp. (°C).....	9.3	11.6	15.1	20.0	26.0	30.7	33.4	33.6	30.0	24.6	16.4	11.4	21.8
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—7.4
	Days with temperat. above 5°C.....	—	—	—	—	—	—	—	—	—	—	—	—	365

* In this and the following tables we present the average data for observations carried out over many years (at least ten). Average data for shorter periods of observation are indicated in each individual case.

Wheat (Figures 42, 44) and barley (Figures 43, 45) are normally sown in autumn in this region; leguminous seed plants are sown either in autumn or spring.



FIGURE 35. Cultivated one-grained wheat—Triticum monococcum L., Germany



FIGURE 36. Wild-growing and high peas, Pisum elatius (M. B.) Stev. Palestine

The local varieties of this region are generally characterized by drought-resistance, particularly in their last development stages, and by short developmental stages. The straw of the wheat and barley is firm and the ear relatively coarse in both. In their last developmental stages, these varieties require warmth. The leguminous seed plants (pea, vetch, grass pea, lentil) are characterized by scant foliage and small flowers; the plant is low, ripens quickly and has large pods; the seed is of medium size.

In the Syrian territory, it must be noted that the varieties cultivated in the Damascus oasis, where irrigation has brought about the development of characteristic new varieties, differ from the assortment grown in the Syrian and Palestinian uplands.



FIGURE 38. Sow pea — Pisum sativum L.
 Syria



FIGURE 37 a. Red-yellow wild pea —
Pisum fulvum Sibth et Sm. Palestine

2. Asia Minor Inner Mountainous Region

The mountainous relief of Inner Anatolia causes a considerable range of climatic conditions. On the whole, Inner Anatolia is characterized by insufficient precipitation and periods of drought. Table 4 indicates the climatic characteristics for a number of points of Inner Anatolia.



FIGURE 37. Red-yellow wild-growing peas - Pisum fulvum Sibth. and Sm. Palestine



FIGURE 38a. Sown peas - Pisum sativum L. Syria

As seen, rainfall ranges from 350 mm to 660 mm; the average temperature fluctuates between 3.9° and 11.7°C, depending on the altitude. In Inner Anatolia sowing takes place as a rule at an altitude of 700-2,000 meters above sea level. As we continue ascending to districts of higher altitude, we observe a predominance of spring types. There are few characteristic types of wheat and barley in Anatolia. Spring types are the most common and among them is a considerable number of late types, a fact which particularly characterizes Turkish soft and Club wheats.

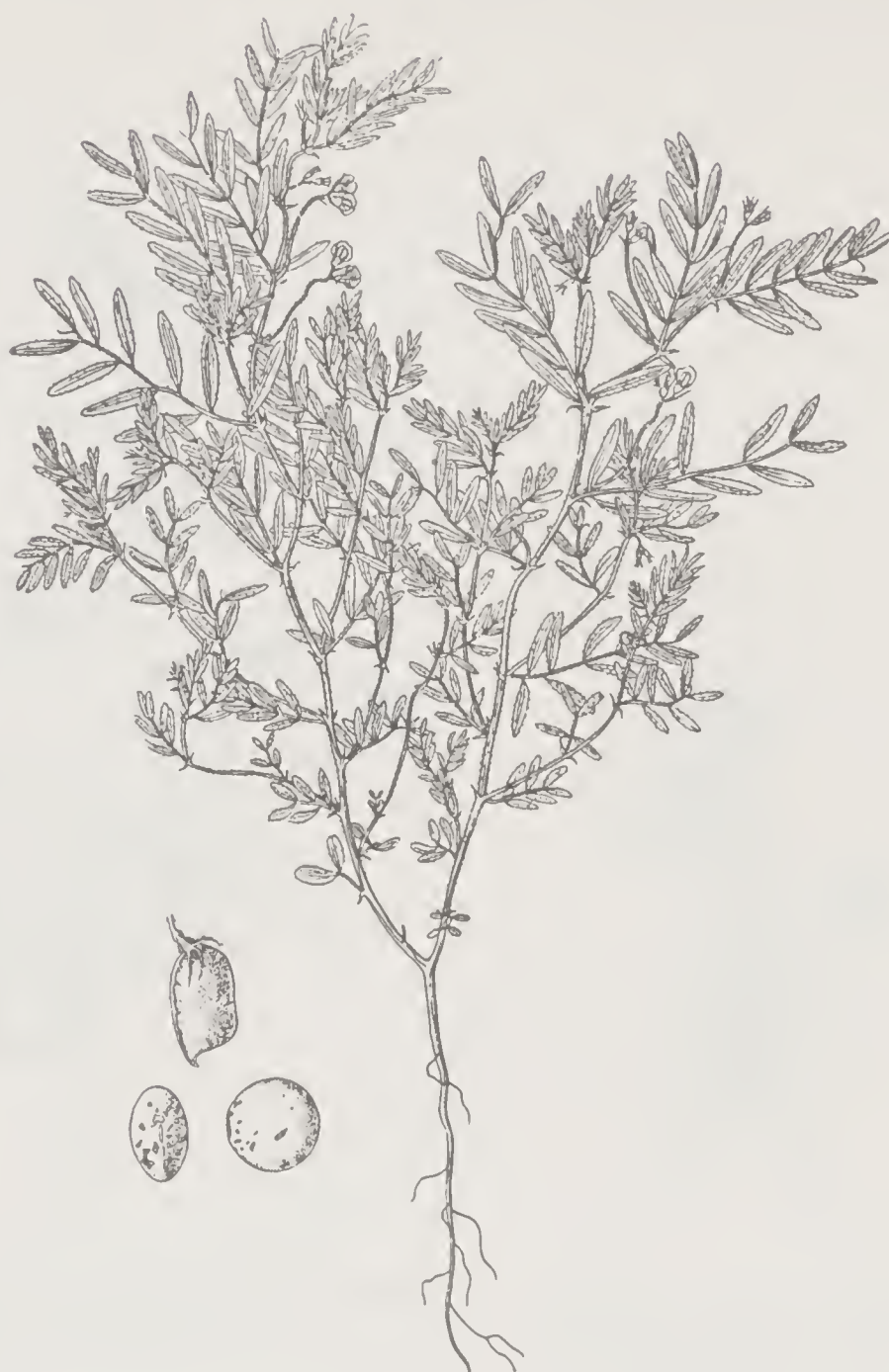


FIGURE 39. Lentils - Lens esculenta Moench, var. Syriaca
Bar. Syria



FIGURE 40. Chick pea - Cicer arretinum L., Palestine

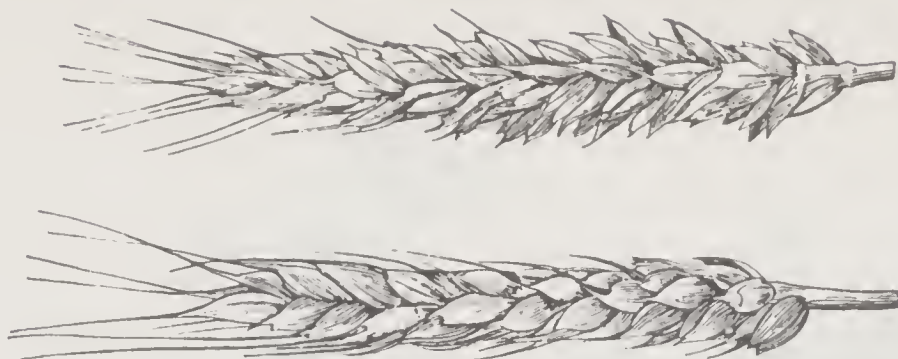


FIGURE 43. Soft wheat—Triticum vulgare vill, Mesopotamia



FIGURE 42. Soft wheat—Triticum vulgare Vill, Syria



FIGURE 41. Wild-growing barley—Hordeum spontaneum C. Koch, Syria



FIGURE 44. Barley—Hordeum
distichon L. var. syriacum Vav.
and Orlov, Syria

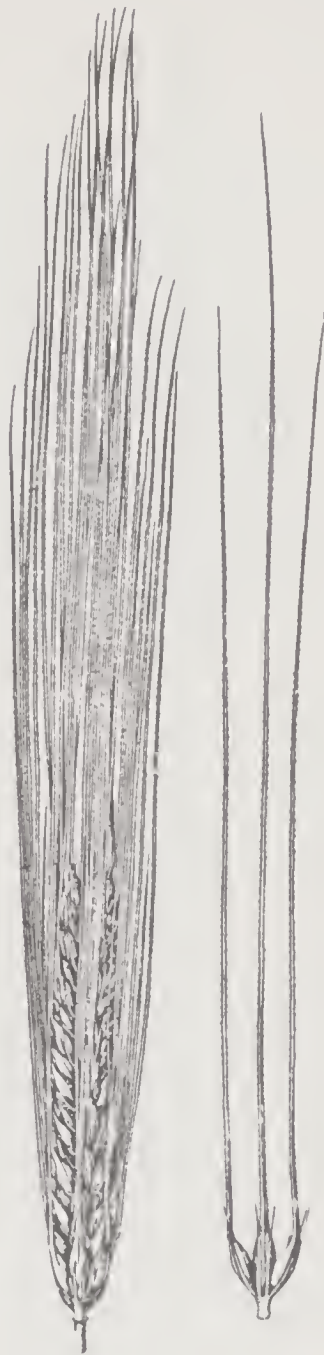


FIGURE 45. Barley—Hordeum
vulgare L. , var pallidum Sér.
Palestine

Table 4

[illegible]

109

According to the research work carried out by Göğköl*, the number of different varieties found in Turkey is exceptionally high, surpassing Iran and Afghanistan in this respect. This author described up to 130 varieties of durum wheat, about 200 of common wheat, about 120 of club wheat, and 70 varieties of English wheat—*T. turgidum*. We also find in Göğköl's work a detailed agroecological classification of these wheats, but based unfortunately on morphological rather than physiological characteristics, particularly the density of the ear.

In Anatolia we found a considerable quantity of beardless common wheats. Some of the durum wheats found in Inner Anatolia, which are particularly characteristic of the Adan-Mersin district, have proved to be record wheats for resistance to fusariosis and Swedish fly when tested in the Kursk and Voronezh regions.

The hard wheats of Turkey are actually more akin to those of Western and Southern Anatolia, where English wheat—*T. turgidum*—is also cultivated. On the other hand, common and club wheats are better adapted to inland Anatolia. The club wheats, the majority of which belong to spring varieties, deserve attention on account of their stout stalk. Beardless varieties are often found among them. In Armenia Minor wild one-grained varieties are found in great abundance. Among the oats, particularly interesting forms belonging to the species *A. byzantina*, resistant to crown rust and loose smut are found here. The barleys of Anatolia belong to relatively few types, but are rather high in yield and resistant to drought.

Inner Anatolia is a center of cultivated and wild varieties of rye, from perennial mountain species *S. montanum*, Guss and psammophytic *S. ancestrale*, Zhuk.* , discovered by P.M. Zhukovskii, to the grain-field weed variety *S. cereale*. Here are found botanical varieties of rye in great quantity, among them many endemic forms. In Inner Anatolia grow a great number of species of *Aegilops*. The ancestral region of the pea is restricted to Anatolia, Syria and Palestine. The majority of species of the genus *Pisum* are found in wild form in Anatolia.

Most leguminous plants are represented by forms with medium-size and small seeds (the large seed tends more to the Mediterranean area). Forms of lentils, beans, chick peas and peas with medium-size seeds are grouped with Persian forms into one botanical-geographical group. Forms with large seeds predominate in Western and Southern Anatolia and those with fine seeds in Eastern Anatolia. The lentils of Anatolia are of great interest; all wild species and a great assortment of cultivated forms are to be found here.

110

Plate-like forms with big grains predominate in Western Anatolia, whereas the Southern Anatolian forms are the intermediary type. The presence of peculiar pea-like chick peas is very characteristic here.

3. Pontic Humid Subtropical Region of Asia Minor

In this ecological region, we include the bordering Abkhazia and Adjara, which are part of the Georgian SSR.

The whole of this region is characterized by a humid climate, a long growth season, and a mild winter.

The region is mainly covered by forests (virgin).

* Mirza Gogkol. Türkiye bugdaylary. Ankara, 1939.

* This grows not in Inland Anatolia, but in its Aegean region.



Northern Palestine. Arab village



Northwestern Palestine. Fixing the dunes



Nomads in Transjordan



Palestine. Oasis of Khan Yunis

Table 5

Average (3 years) climatic data for Trabzon
(41°01' North lat., elev. 30 m)

Data	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Av. precipitation (mm).....	60	64	66	73	26	45	33	66	129	60	111	90	823
Av. temp. (°C).....	7.6	6.7	8.0	11.0	16.1	19.5	22.6	24.2	20.4	17.5	12.9	9.0	14.6
Av. abs. temp. min. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—1.8



FIGURE 46. Cultivated one-grained wheat einkorn—Triticum monococcum L., Turkey



FIGURE 47. Soft wheat—Triticum vulgare Vill., xerophyl form, Turkey

14

We may observe here untouched tertiary leaf forests rich in characteristic species, such as Albizzia julibrissin Durazz and the iron-tree Parrotia persica (DC) C. A. M. Considerable areas are until today covered by leafy forests.

The climatic characteristics of Trabzon, which are typical of the whole Prepontic subtropical ecological zone, are given in Table 5 .

At present, the region is chiefly sown with corn. Wheat was formerly cultivated, and apparently endemic Caucasian species— Triticum georgicum Dek. (Figure 48), T. macha and T. timopheevi penetrated here.



FIGURE 48. Georgian wheat—Triticum georgicum Dek., Georgian SSR



FIGURE 49. Flax—Linum usitatissimum L., Creeping form, Abkhazian SSR

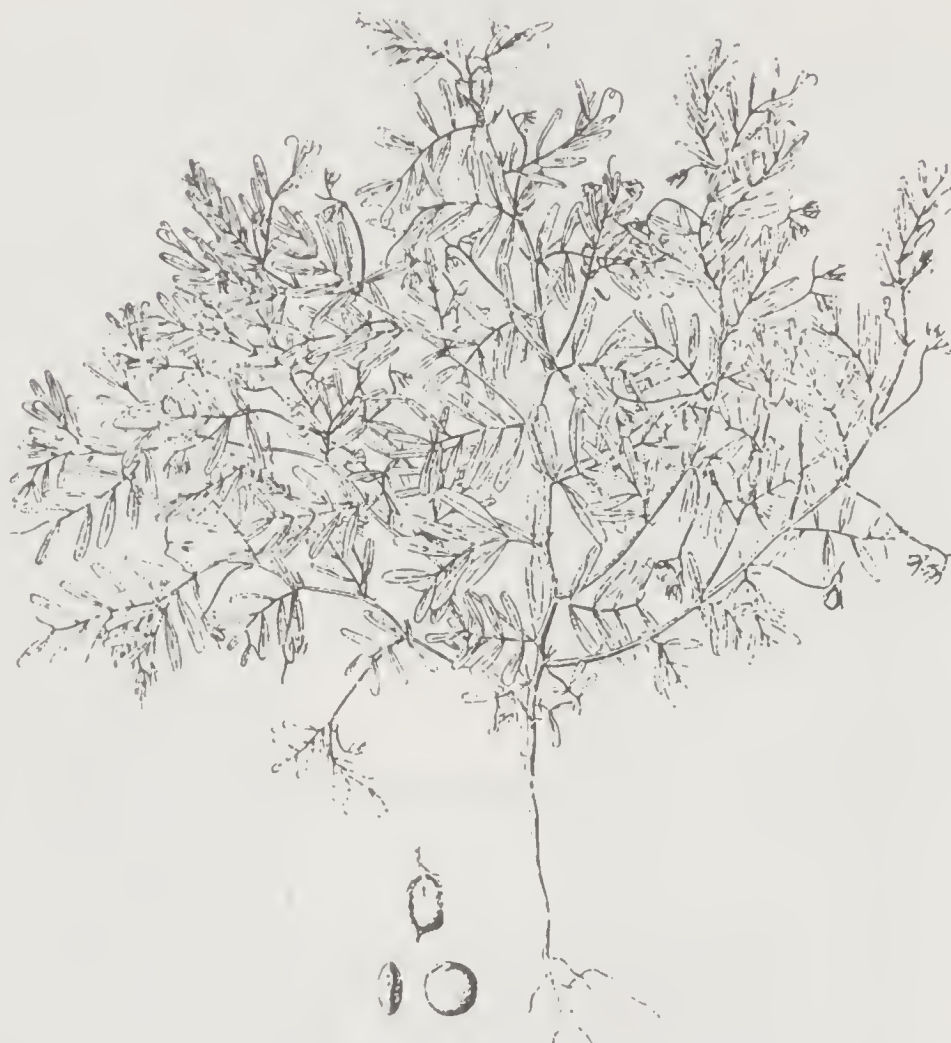


FIGURE 50. Lentils - Lens esculenta Moench. Var. subnummularia Bar. Turkey. Denizli

Cultivated spreading flax (recumbent type) is endemic in these regions (Figure 49), with branches in the form of candelabra. These are generally late types and are sown in autumn. In the past, this flax was used for fiber. Recumbent flax, as well as lentils, are to be found mainly in Northern Anatolia, Abkhazia and Lenkoran, but also in the villages of Kastamonu, Samsun, Smyrna, and Mugla. Usually these flaxes grow at altitudes of 300-400 meter above sea level, particularly on light soils, and they develop deep roots.

Caucasus (in the Broad Geographical Sense)

115

The highways built in the course of the last decade (1931 - 1940), have made possible precise research in all agricultural areas of the Caucasus (the whole of the geographical Caucasus). Besides the great number of specialized expeditions of the All-Union Institute of Plant Breeding, important research was carried out by M.G. Tumanian and his fellow workers in Armenia, Prof. L.L. Dekaprelevich and V.L. Menabde, in Georgia, and V.N. Gromachevskii in Azerbaijan; thus, a vast amount of genetic material was studied.

The entirely schematic and inaccurate notions held by such ecologists as Azzi and Papadakis concerning the Caucasus, in the best of cases dividing it into Transcaucasia and North Caucasus, demand thorough revision.

116



FIGURE 51. Wild two-grained wheat (spelt)—Triticum dicoccoides Korn, Armenian SSR



FIGURE 52. Wild-growing barley—Hordeum spontaneum Koch, Trans-Caspian region

For an understanding of the genesis of cereals, the Caucasus is of far greater significance than some **investigators** have visualized.

The broad territory of the Caucasus, including the mountain and foothill areas of both the Main Range and also the Small Caucasus, is, as shown by comparative research on the agriculture considered by us, an exceptional phenomenon from the point of view of species and variety resources of which quite insufficient account has been taken in the past.

Within the borders of Armenia, a great assortment of wild one-grained and two-grained plants is concentrated. (Figure 51). As far as variety of species of cultivated and wild wheats is concerned, it has been shown by the findings of Soviet researchers that the Caucasus occupies the first place in the globe. In contrast to Anterior Asia, we here meet maximum contrasts in physiological properties, particularly in immunity of infectious diseases. It is precisely here that cultivated species characterized by exceptional resistance to fungus diseases, such as T. timopheevi and T. persicum, have been found. Along the shores of the Caspian Sea, in Daghestan and Azerbaijan are numerous wild two-rowed barley types (Figure 51). As far as the variety of species of wild rye is concerned, the Caucasus is first in the entire world, competing even with Anatolia in this respect. In recent years a number of species of wild rye has been discovered here, such as S. vavilova, S. daralagesi Tun., S. chaldicum Fed., S. digoricum Vav.



FIGURE 53. Field weed rye—Secale cereale L., Brittle black-ear form, Trans-Caucasus



FIGURE 54. Field weed-rye—Secale cereale L., Brittle white-ear form, Trans-Caucasus

A great variety of field weed-oats is found contaminating sown areas of barley and two-grain wheat particularly. Leguminous crops—chick peas, lentils, peas—are represented by a large variety in addition to the original genus which, as it were, combines the properties of peas and grass peas, and which was established by A. A. Federov under the name Vavilovia. A detailed study of the species and forms of wild and cultivated rye in recent years has made it possible to establish the whole series — from perennial wild forms to field-weed spring forms with an exceedingly brittle ear which crumbles at maturation (Figures 53-56) and which contaminates



Caucasian expedition of the USSR Academy of Sciences (1939) into Northern Osetia—Village of Styr-Digori



On the Kuban Experimental Station of the All-Union Institute of Plant Breeding (1926). Seated Academician N.I. Vavilov, at left, Director of Station, A.I. Orlov



Caucasian Expedition of the USSR Academy of Sciences,
1939, into Northern Osetia. Road to village of Styr - Digori



Krasnodar territory, the foothill zone of the Northern
Caucasus (Tula area), village of Shuntuki. Photograph
by P. P. Gusev

sown areas of wheat and barley — in the northern mountainous path of Osetia, in Digori. Here we succeeded in studying the complete genesis of rye as a cultivated plant and its connections with the wild and weed-field forms. For an understanding of the evolution of wheat and rye, the Caucasus constitutes an exceptional phenomenon and almost every year produces new finds of high value for the elucidation of the evolution of these highly important cultivated plants.

Agroecologically, the Caucasus is distinguished by an exceptional variety of conditions. The Black Sea Coast is characterized by a large quantity of rainfall, which in the area of Batum exceeds 2,500 mm per year. In certain points in the high mountainous western part of Caucasus, the amount of rainfall exceeds 3,000 mm. The highly elevated areas in the hinterland of the Caucasus also suffer comparatively from an excess of moisture. On the other hand, on the Apshiron, in the Eastern part of the Caucasus, the annual amount of rainfall does not, on the average, exceed 180 mm. The climate remains a desert one. Agriculture is possible only by means of irrigation.



FIGURE 55. Field weed-rye — Secale cereale L., Semi-brittle form, Trans-Caucasus

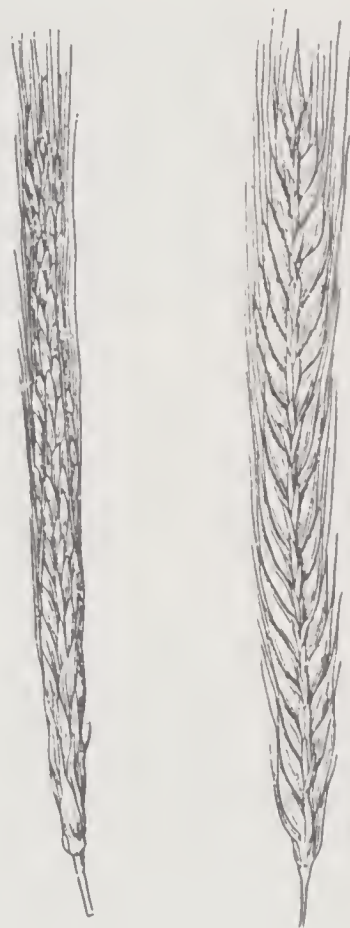


FIGURE 56. Field weed-rye — Secale cereale L., Azerbaijan SSR

The high mountain areas of the Caucasus are characterized, as a rule, by excess humidity, in contrast to the dry Central Asian mountains, steppes and deserts. This generalization is complicated by the existence of parallel ranges, such as the Skalisty or Bokovy in the north of the Caucasus, which arrest the rains brought by northwestern winds, thus creating a comparatively dry intra-zone territory (the steppe areas along the Baksan and Chegen canyons in Kabard, in Uch-Kulan, the foot of Elbrus, and also along the canyons of Northern Osetia). Generally speaking, as we proceed from west to east in the Caucasus, there is an increase in the continental character and the dryness of the climate.

Particularly unique conditions exist in the southern part of the Transcaucasia bordering on Iran. The areas of Lenkoran and Astara directly adjacent to the Caspian Sea are characterized by sufficient rainfall, attaining 1,124 mm per year in Lenkoran despite a markedly dry summer. The region is one of well-preserved tertiary leaf-covered forests.

The Zuvand mountain areas bordering on the west of Lenkoran are, as it were, a jutting out of the Ukrainian plateau, distinguished from Coastal Lenkoran by a dry climate and, accordingly, by a different type of cultivated plants, represented chiefly by typical natives of the hinterland of Iran.

An even drier climate is characteristic of the areas of Nakhi Shevan along the Araks River, close to the hinterland of Iran, where agriculture is essentially irrigated. The wheats and barleys of the areas of Nakhi Shevan are obviously of Iranian origin.

The northern slopes of the Main Caucasian Range are distinguished by comparatively humid and severe winter conditions. Accordingly, the most winter-resistant forms of winter barley in the world have evolved here. On the slopes of the Main Caucasian Range, in the direction from the Suram pass in Kakhétia towards northern Azerbaijan, under conditions of a relatively dry climate, there have appeared special local forms of dry wheat, (*Dolispuri*) (Figure 57).

In West Georgia, where there is a mild, moist climate, there have appeared endemic species of wheats, such as *T. timopheevi*, *T. macha*, *T. georgicum*, which are not encountered anywhere else in the world.

The areas of Daghestan and Azerbaijan bordering on the Caspian are characterized by a mild climate with long growth period. Under conditions of an abundance of water for purposes of artificial irrigation and the absence of the destructive action of dry winds, thanks to the moderating action of the sea, ecotypes of large-ear hard winter wheats of remarkable productivity have developed, unknown in other agricultural regions of the globe (Figure 58).

The Caucasus is part of the focal region of development of species of wheat, barley, rye and flax, and thanks to the varied conditions, mountainous nature, and ancient culture, in particular in the Trans-Caucasus and Daghestan, there developed an exceptional multifariousness of ecotypes presenting striking contrasts when compared under identical conditions. Quite often, entire botanical species correspond to a single established ecotype. Many of the endemic Caucasian species of wheat, rye, and wild and cultivated fruits have never left the borders of their initial birthplace. It is well known that the Caucasus is characterized by an exceptionally rich flora. Of 16,000-17,000 species peculiar to the Soviet Union, 6,000 species are concentrated on the comparatively limited territory of the Caucasus*.

Among the wild flora of the Caucasus are a large number of species genetically close to the cultivated plants we have examined. This multitude of varieties and species of cultivated plants was favored by the exceptionally large number of native peoples inhabiting the Caucasus. The Small Caucasus and the Main Caucasian Range served as territories through which passed multitudes of people from Anterior Asia with their flocks. The rich pasturage favored the settlement here of these people. The mountain areas of Daghestan lead all other areas in the numbers of peoples speaking different languages. The Caucasus has been quite correctly called a "heap of languages". Agriculture in Armenia, Georgia and Daghestan is extremely ancient. Its origins go back thousands of years.

* A.A. Grossheim. "An Analysis of the Flora of the Caucasus." Baku, 1936.

Among the cultivated plants of the Caucasus, we have established endemic species of cultivated plants and their nearest wild ancestors, including a large



FIGURE 57. Soft wheat - Triticum vulgare Vil. Dolis-Puri variety, Georgian SSR

number of species of wheat, rye and particularly fruit trees. Agriculture in the Caucasus is practised at heights of 2,500 meters above sea level in the North Caucasus and in Daghestan, and up to 2,700 meters in Trans-Caucasus and Armenia.

123



Giants from the collection of Mexican French beans at the Sukumi Experimental Station



Fields of the Sukumi Experimental Station sown with corn from Central Mexico. At left M. I. Khadzhinov. At right I. V. Kozhukov



Maikop Experimental Station (1934). Academician
N.I. Vavilov inspecting portion of plum plantations.
Photograph by E. P. Gusev



Maikop Experimental Station :
Blossoming of wild pear

The variety of agricultural conditions the Caucasus occupies a foremost position in the Soviet Union, going up to extreme limits bordering on eternal snow, and correspondingly characterized by a brief growing period. As we shall see later,



FIGURE 58. Hard wheat - Triticum durum
Desf., Semi-winter, Azerbai-
jan SSR

the agroecological groups of wheats, barleys and rye, as well as leguminous crops and flax, display an exceptional variety, the presence of endemic species and a sharp genetic differentiation, connected with the proximity to the basic centers of species development of the given plants. In the range of ecological and physiological

126 differences, the Caucasus presents extreme contrasts, from typical hygrophytes and mesophytes to typical xerophytes, from warmth-loving forms of the subtropical areas to the highly winter-resistant and cold-resistant forms of the Northern Caucasus. The variety of conditions, the combination of warmth, and moisture more or less favoring the development of fungal infections, have made possible the development of sharp contrasts in immunity to rust, powdery mildew and other diseases. In the high mountains of Daghestan, a peculiar group of large seed, two-rowed naked barleys has developed (Figure 59), as well as a special species of wheat—*T. persicum* resistant to germination of grain on the spike. The multitude of varieties of ecotypes may be judged especially vividly in such crops as wheat, barley and flax. In the Pontine region of the Caucasus, there developed original prostrate or creeping forms of flax, found also in Lenkoran and adjacent areas, which are usually grown from the autumn and are, in effect, winter forms. In the high mountains of Daghestan, Georgia, and Armenia, special low, rapidly maturing oleaginous curly flaxes have evolved. In Azerbaijan, at the foot of the Main Caucasian Range, there are original oleaginous flaxes looking like typical Argentinian flaxes with sparse branches and large bells and seeds. The steppe areas of the Caucasus are characterized by a concentration of typical intermediate-fiber, non-branchy, medium height oleaginous flaxes. The Caucasus, as it were, is a giant ecological laboratory, where in the course of centuries and millenia, in the vicinity of the basic centers of species formation, special ecotypes of the cultivated plants examined have developed.

The study of various conditions in the mountainous and foothill parts of the Caucasus, the ecological analysis of species and varieties of plants which has been carried out during the last decade, the comparison of the ecotypes of the Caucasus with other regions and areas, all this enabled us to delineate 12 agroecological areas in the region. The comparatively small size of the territories compels us to call these areas and not regions.

127 4. Moist Mountain Regions of Western Georgia

This includes the areas of Western Georgia adjacent to the Suran Range, located to the north of Kutasi, the areas of Lechkum and Rachi, and partly the territories of the administratively adjacent areas. Thanks to the fact that it is protected from cold air currents by the Main Caucasian Range to the north, this territory is characterized by a mild climate and a comparatively warm winter. On the average, the rainfall is 800 - 1300 mm. Sowing of wheat is carried out principally in autumn. Lately corn has become widespread, displacing wheat and barley. Before corn arrived, Italian millet (*Setaria italica* L. Beauv.) was also grown in large quantities. It is only from isolated islands that we can judge about the old aboriginal cultivated flora of this remarkable region which in recent years has given most interesting finds in wheat. Among the vestiges of the cultured flora of Western Georgia the researches carried out by L. L. Dekaprelovich, V. L. Menabde and P. M. Zhukovskii have uncovered original endemic species of wheat such as *T. macha*, *T. georgicum* and *T. timopheevi* together with unique agroecological groups of soft wheat, one-grained varieties, and *T. turgidum* (Figure 60). A mixed variety of species, differing in the number of their chromosomes has been concentrated here on an insignificant area. Among these was discovered the original species of *T. timopheevi*, which was different from other species of wheat, as shown by the study of Kihara*.

As in single-grained varieties, Timopheevi's wheat possesses an exceptional compound immunity to a multitude of wheat diseases, such as bunt and loose smut, brown and yellow rust, and powdery mildew. This species, like the single-grained varieties, is resistant to infection by Swedish and Hessian flies. In the endemic winters the two-grained varieties are characterized by a comparative resistance to infection by fungi.

* Kihara, Genomanalyse bei *Triticum* und *Aegilops*. *Triticum timopheevi*, Zhur. Cytologia, V. 6, No. 1, 1934, pp. 87-122.



FIGURE 59. Naked grain barley - *Hordeum distichon*, L., var. *daghestanicum*, Vav. et Orl. Daghestan ASSR



FIGURE 60. English wheat - *Triticum turgidum* L., Kakhelia



FIGURE 63. Sow pea — Psidium salivum L.
Georgian SSR, Bakuriani



FIGURE 118. Sow pea — Psidium salivum L.
Morocco

The variety of species and forms of wheat here was probably even more pronounced in the past. The majority of the forms of wheat of West Georgia are either winter, late spring or semi-winter forms. Of the soft wheats, exceptionally interesting forms of beardless wheat known as Khulugo were brought to light here (Figure 61), which were already known during the times of Schot Rustaveli. These forms are distinguished by a large cultivated ear, strong stalk, and an external appearance resembling that of Western European sandomirs. The existing endemic species and forms of wheats and certain barleys (Figure 62) of Western Georgia are of quite exceptional interest for selection, thanks to their remarkable combination of properties.



FIGURE 61. Soft wheat *Triticum vulgare* L., local variety. Rach'ul (Khuluga), Georgian SSR.



FIGURE 62. Barley - *Hordeum distichon* L., var. *nutans*, Schubl., subvar. *colchicum*, Reg. Trans-Caucasia.

The climatic conditions of this region may be judged to a certain extent from those of Kutaisi, situated 50 kilometers from the Lechkhum area, where the above-mentioned endemic wheats were found. The amount of rainfall here is rather on the excess side and occurs particularly in autumn and winter (Table 6).

Table 6

Climatic data for the Kutaisi area (Georgia),
(42°17' North lat. , elev. 156 m)

Data	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Precipitation (mm).....	106	131	105	118	89	108	104	82	120	105	151	142	1361
Av. temp. (°C).....	4.7	5.8	9.0	13.8	18.3	21.3	23.4	23.9	20.4	16.7	11.4	7.4	14.6
Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—10.4

5. Mountain Steppe Comparatively Dry Regions of Georgia and Azerbaijan
450 - 1,500 m Above the Sea-Level

This includes areas stretching from the Suram range in the direction of Kakhetiia within the boundaries of Georgia, and also comprises the northern mountainous areas of Azerbaijan, neighboring Nukhe and Shemakhe. The growth of cereals occupies considerable areas here.

These areas are located in the intermediate zone between the high mountains, foothills, and low-lying areas, and include considerable cereal cultivation covering many tens of thousands of hectares. Geographically speaking, this territory embraces the region from the Suram Pass to Gori and Mtskheto-Tbilisi, stretching from there into Kakhetia, and ranging on the slopes of the Main Caucasus Range into Azerbaijan, Nukhe, and Shemakhe, entering the borders of Daghestan. Here, cereals are grown both with and without irrigation, non-irrigated cultivation being most widely-spread. In the past this territory was occupied by mountain steppes, most of which have been plowed up and brought under cultivation. On the average the zone is characterized by rainfalls of 350-700 mm, comparatively uniformly distributed. A favorable factor is the comparative humidity of the months of May and June. We observe periodically the destructive action of drought. Thanks to the elevation of 450-1,500 meters above sea level, the temperature is not high. The climatic characteristics of the area are shown in Tables 7-8. Sowing wheat and barley is carried out chiefly in autumn, rarely in spring. As a result of the fairly harsh climatic conditions, types of wheat and barley, as well as leguminous grains have been formed with comparative resistance to drought (Figures 63 - 64).

In Georgia and partly in the mountainous part of Azerbaijan, there has evolved a typical winter known in the areas of Tbilisi and Mtskheth by the name of *Dolis puri* (Figure 57), distinguished by a relatively low height, soft spike, soft beard, small grain, and slender axis. The spike of this wheat resembles that of *Triticum persicum*. Far-flung areas of the Gorii, Metskhe and Kakhetia areas are sown mainly with *Dolis puri*. In the mountain areas of Azerbaijan, mountain wheats are most widespread, represented overwhelmingly by late-maturing semi-winter

Table 7 -

Climatic data for the mountain-steppe areas of Georgia, Azerbaijan and Daghestan

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Shemakha, (Az. SSR), 40°38' North lat. Elev. nearly 725 m	{ Precipitation (mm).....	24	41	37	56	54	41	47	26	44	52	42	29	493
	{ Av. temp. (°C).....	0.3	0.3	4.2	8.7	15.1	19.8	23.4	22.8	18.1	18.1	7.0	3.0	11.7
Tbilisi (Georgian SSR), 41°43' North lat. Elev. 409 m	{ Precipitation (mm).....	12	21	28	53	90	80	47	36	44	43	35	24	513
	{ Av. temp. (°C).....	0.6	2.7	6.3	11.9	17.0	20.3	24.1	24.0	19.3	13.7	7.4	2.7	12.7
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—18.4
Nukha, (Az. SSR), 41°12' North lat. Elev. 736 m	{ Precipitation (mm).....	23	31	55	83	93	78	43	40	98	67	52	31	704
	{ Av. temp. (°C).....	0.6	0.9	5.5	11.0	16.7	21.2	24.3	23.2	18.4	12.9	6.5	3.0	12.1
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—14.6
Akhty, (Dagh ASSR), 41°27' North lat. Elev. 1,210 m	{ Precipitation (mm).....	9	19	15	34	52	44	42	31	47	20	14	13	340
	{ Av. temp. (°C).....	—2.9	0.0	3.4	7.9	13.6	16.9	19.4	19.3	15.3	1.1	4.4	0.0	9.0
	{ Days over +5°C.....	—	—	—	—	—	—	—	—	—	—	—	—	230

Table 8

Climatic data for high mountain steppe areas of Armenia, Georgia and Daghestan

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Novo-Bayazet (Arm. SSR), 40°20' North lat. Elev. 1964 m	{ Precipitation (mm).....	19	20	34	44	66	77	50	31	45	20	19	16	435
	{ Av. temp. (°C).....	-7.9	-5.5	-2.3	3.5	8.8	13.1	16.3	16.4	11.8	6.8	0.0	-5.2	4.6
	{ Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-25.2
Elenovka, (Arm. SSR), 40°32' North lat. Elev. 1,940 m	{ Precipitation (mm).....	19	20	33	59	101	67	41	40	35	43	40	20	518
	{ Av. temp. (°C).....	-8.1	-5.9	-2.3	3.7	8.6	12.8	16.3	16.6	13.2	7.9	1.1	-4.6	4.9
Akhalkalaki, (Georgian SSR), 41°25' North lat. Elev. 1,715 m	{ Precipitation (mm).....	17	23	24	60	79	112	61	49	42	52	28	23	570
	{ Av. temp. (°C).....	-6.9	-4.9	-1.4	5.0	10.3	13.4	16.3	16.8	12.8	7.5	1.5	-3.6	5.6
	{ Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-26.3
Khunzakh, (Dagh ASSR), 42°34' North lat. Elev. 1,695 m	{ Precipitation (mm).....	4	8	19	45	84	118	114	73	57	24	12	7	565
	{ Av. temp. (°C).....	-5.8	-3.4	-1.6	5.7	10.8	14.2	16.4	16.4	12.5	8.2	1.4	-2.0	6.1
Leninakan, (Arm. SSR) 40°48' North lat. Elev. 1,532 m	{ Precipitation (mm).....	20	17	24	56	104	69	49	37	27	33	22	22	480
	{ Av. temp. (°C).....	-9.7	-7.1	-1.0	6.6	11.2	15.7	19.6	19.5	15.1	9.2	1.8	-5.5	6.3

- 132 types of late spring forms distinguished by comparatively large spikes and kernels. The morphology of the spikes reminds us of Mediterranean wheat. Of the Daghestan and Azerbaijan lowland hard wheats, the types grown in the hinterland mountain part of Azerbaijan are distinguished by rather small grains (weight of 1,000 grains approximately 45-50 grams). We also meet admixtures fairly frequently here red-ear and black-ear species. The hard wheats of Georgia are called Tavitukhi (Figure 65) or Tatukhi. Hard wheats are usually grown in Cartalinia and Kakhetia.

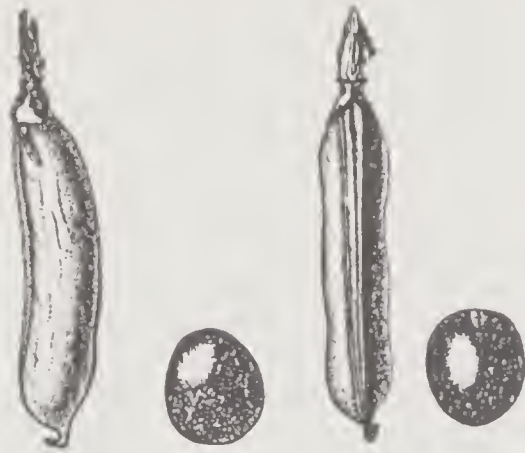


FIGURE 64. Asiatic subspecies of beans - *Vicia faba* L., ssp. *pauciluga* f. *daghestanica* Murat, Daghestan ASSR, Beans 3:4; seeds 5:3

6. High Mountain (Over 1,500 Meters Above Sea Level) Sufficiently Humid Steppe Areas of Armenia, Georgia, and Daghestan

The agricultural areas of the high mountain part of the Caucasus occupy a large territory including the high Armenian mountain plateau and the high mountain part of Georgia. This includes ecologically also the high mountain part of Daghestan, where large areas consisting of tens of thousands of hectares are under cultivation. The temperature is sufficient for the maturation of spring cereals. Basically spring cereals are predominant. It is only rarely that winter wheats enter the region.

The agricultural areas of the high mountains, both of the Main Caucasus Range and the Small Caucasus, are characterized by the widespread presence of the so-called Persian wheat (*T. persicum*), resistant to powdery mildew and to a considerable extent also resistant to various types of rust. This species is endemic to the high mountain part of Daghestan, where it is represented mainly by black-eared pubescent forms. To a considerable degree it is also widespread in the high mountains of the Trans-Caucasus. Physiologically the species is distinguished by resistance to cold, speedy maturation, and non-germination of grains while on the stalk, even under damp weather conditions, while Daghestan is characterized predominantly by the black-eared pubescent forms of *T. persicum*, Georgia, and Armenia, on the other hand, are characterized by the white-eared and red-eared smooth forms. This species enters also into the northeastern high mountain part of Turkey in small quantities. As far as we know, *T. persicum* is exclusively represented by spring forms. A typical feature of *T. persicum* is the grasslike grain, resistant to various conditions even when grown in the north. The species has the karyotype of hard wheat (28 chromosomes), and is easily crossed with the latter, yielding fertile hybrids, but, ecologically speaking, is close to soft wheat, differing from this by being undemanding as regards soil conditions as it grows successfully on gravel soils. Persian wheat is an interesting component to cross with durum wheats with the aim of pushing the latter towards the north.



FIGURE 65. Hard wheat - Triticum durum Desf. ("Tavtukhi"), Georgian SSR

We also meet here with the cultivation of typical two-grained Armenian wheat characterized by swift maturation. One also finds here winter wheats of the Prebanat kind very similar to our steppe Banats, differing from Dolis puri by its spiked axis, larger grains, and fair resistance to winter conditions. The climatic and even the soil conditions of the high altitude steppes of Armenia and the adjacent areas of Georgia resemble those of the Ukrainian steppes. The plain character of the high mountain steppes of Southern Georgia and Northern Armenia, despite their height of 2,000 meters above sea level, makes it possible to employ tractors and harvesting machinery. The similarity of the climate of the Ukraine steppe to these high mountain steppes is evidenced by the fact that the standard winter wheats of the Ukraine have been grown successfully here in recent years, including Kooperatorka, Zemka, Steppniatchka and Ukrainka. Real durum wheats are not present in the high mountain areas of the Caucasus.

The high mountain regions of Daghestan have a concentrated cultivation of a peculiar highly productive two-row naked variety of barley characterized by a large grain with no tendency to germinate on the stalk. A serious shortcoming of these barleys when transferred to steppe and forest steppe areas is unfortunately their marked recumbent tendency and their vulnerability to fungi of the genus Helminthosporium. Peculiar leguminous grains have evolved here a special species of Daghestan lentils, indigenous circular black Daghestan beans — Vicia faba (Figure 64). The peas of the high altitude parts of the Caucasus constitute a special subspecies distinguished by the minuteness of its seeds, narrow leaves and comparative resistance to drought. The high altitudes of Daghestan are also characterized by early maturing endemic forms of flax plants of low height used for their oil, which is here consumed in a mixture with ram's fat. Together with Persian wheat there have here been discovered soft spring wheats morphologically and ecologically very akin to Persian wheat and distinguishable from the latter only with difficulty. These we classed in the group T. vulgare gr. persicoides Vav.

7. Moist Region of Zakataly

The Zakatal humid area is ecologically sharply distinguished from the Caucasian areas described above. It is located at the southern foot of the Main Caucasian Range, partly along the valley of the Alazani river, and administratively speaking includes both a part of Eastern Georgia (Kakhetia) as well as Northwest Azerbaijan (Belokhan and the Kakhse areas). This ecological area is distinguished by a mild, comparatively humid and almost subtropical climate. The average annual rainfall is 900 mm, occurring mostly during the summer. The abundance of mountain waters flowing down from the southern slopes of the Main Caucasian Range offer rich possibilities for the application of irrigated cultivation. As shown by the most recent research, the cultivation of tea is possible here, as well as Japanese persimmon and late types of rice. The local assortment of wheat types is comparatively motley, though chiefly a type of Prebanat and to some extent Dolis puri. Experiments conducted by the Zakatal Experimental Station have shown the possibility of growing selected Italian wheat, such as Arditto (Figure 66) and Carlotta Strampelli. English wheats — T. turgidum — grow successfully and stand up well to winter conditions.

The climatic conditions really resemble those of the foothill areas of Southern Europe, with a somewhat different rainfall distribution, chiefly in the summer instead of autumn, winter, and early spring, as is typical for Mediterranean countries (Table 9).

One of the greatest difficulties for cultivation here is the large number of small streams flowing down from the Main Caucasian Range, carrying with them a multitude of stones.

Table 9

Climatic data for the Trans-Katal humid area

Data	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Precipitation (mm).....	28	29	62	95	138	114	69	76	141	61	61	30	904
Abs.temp. (°C).....	1.5	3.6	7.9	12.5	17.0	21.0	24.3	23.6	18.1	13.6	7.3	4.1	12.9
Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-16.3
Days over + 5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	273



FIGURE 66. Soft wheat - Triticum vulgare Vill. Arditto variety, Italy

8. Dry Armenian Highlands

To the north of Erevan in the direction of Aleghez and Daraleghaz at the height of 900 - 1,500 meters ,the area is characterized by a hot dry climate (Table 10). This is a region of dry steppes. Cultivation here is predominantly by irrigation. The soils are serozem (grey soils) .

In conformity with the dry climate, xerophilous wheats (Figure 67) and barleys (Figure 68) have chiefly evolved. The region is one of widespread local varieties typical of the dry uplands of Armenia, of the type of beardless Galgalos. We encounter large quantities of wild wheat — Triticum dicoccoides, as well as broad two-grained forms, wild two-rowed barley — Hordeum spontaneum — and a large variety of species of Aegilops, wild species of rye: S. vavilovii, S. daralagesi. Cultivated barleys are represented by xerophytic two-rowed forms,

- 137 distinguished by a recumbent stalk at the beginning of development and by narrow leaves. The conditions of this region resemble those of the dry uplands of Syria, where there are also large quantities of wild wheat and wild barley. Corresponding to the high elevation of mountains, the climate in Armenia becomes more severe than in Syria. The local flora of wheat is exceptionally rich in species. We meet considerable quantities of various dwarf wheats — *Triticum compactum*. In the area of Lake Van, which is now part of Lesser Armenia, together with a large variety of dwarf wheats, an endemic species has been discovered — *T. vavilovii*, distinguished by difficult threshing, an exceedingly coarse ear, and extreme drought tolerance. The variety of wild one-grained and two-grained forms, as well as cultivated wheats, is exceptionally great, placing the region in one of the first rank positions in the Soviet Union for botanical varieties. There is no doubt that it is part of the primary region of development of wheats and barleys as well as rye. Peculiar xerophytic forms of chick pea (Figure 69) are grown here. As already noted, An. A. Fedrov in the same area found an original family of Vavilovia, with the properties of grass peas and peas. The aboriginal wheats, which we grouped together into a single xerophytic group, are distinguished by being comparatively prone to disease, and even *T. urartu* Thum., found by M. Thumanian, which cytogenetically belongs with single-grained forms ($2n = 14$), is characterized by comparative proneness to infection by yellow rust.

9. Karabakh Mountain Region

The high upland area of Karabakh, located to the east of Armenia and west of Zangezur, is characterized by a milder climate than the high mountains of Armenia (Table 11). The uplands of Karabakh differ considerably from the high mountains of Armenia in the flora of species and types of wheat. To this day we encounter here large numbers of peculiar large-eared single-grained and two-grained varieties, constituting a special agroecological group, characterized by susceptibility to stinking smut. The single-grained types are characterized by tall height, wide leaves and large ears, resembling to a certain extent those of the Spanish forms. The single-grain types are frequently grown in mixtures with two-grain forms, while at times they accompany soft wheats. Both two- and one-grained types are late spring forms. Soft wheats in the upland part of Karabakh are represented by winter forms of the Prabanat type. Sowing is usually carried out in the autumn.

The peculiar flora of species and types, which includes a series of endemic forms, compels us to establish this territory, although a limited one, as an independent ecological area suitable for further, more detailed study.

10. Nakhichevan Irrigation Regions (Near Arax River)

Directly adjacent to the hinterlands of Iran, the Nakhichevan area which now constitutes the Nakhicheva ASSR is characterized by a dry climate and an agriculture based exclusively on irrigation. The flora of wheat and barley types resemble that of interior Iran, with considerable quantities of typical Persian wheats with dark scale-edges. Expanded forms with typical bent scale prongs are grown in large numbers.

It was here that for the first time in the Soviet Union we encountered a flora of species exceptionally similar to that of the Iran hinterland, which we had studied in detail. Winter forms are the principal crop here, having a coarse brittle ear, causing



FIGURE 67. Soft wheat - Triticum vulgare
Vill. Armenian SSR

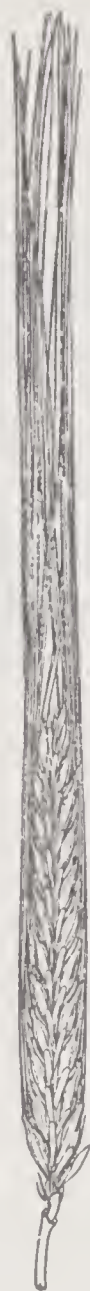


FIGURE 68. Barley—Hordeum distichon L.,
var. nutans Schubl.,
Armenian SSR



FIGURE 69. Chick pea - Cicer arietinum L., Armenian SSR

140 serious difficulties in threshing, but resistant to drought in the later phases of development. We classed these with the Iranian-Turkestan subspecies of soft wheats, T. vulgare, ssp. irano-turkestanicum Vav. The soft wheats of Nakhichevan differ from typical Irano-Turkestan forms only by a certain degree of resistance to leaf-rust.

11. Caspian Insufficiently Moist Region (Foothill and Lowland Regions of Eastern Daghestan and Azerbaijan)

The low-lying and foothill lands located between the Caspian Sea and Main Caucasian Range are characterized by a comparatively mild semi-arid climate (Table 12) where cultivation is usually based on irrigation. Thanks to the influence of the dry Caspian breezes, the growth period is very prolonged. The deep alluvial soils are extremely fertile. Sowing of grains is as a rule carried out in autumn, in the month of October.



FIGURE 70. Hard wheat - Triticum durum, Desf. Daghestan SSR

The Caspian regions of Daghestan and Azerbaijan are characterized by the widespread cultivation of wheat, represented chiefly by durum wheat species (Figure 70) with an admixture of T. turgidum and common wheat. As shown by comparative research of large assortments of samples of durum wheat, the region has winter and semi-winter

- 141 forms responding well to vernalization. The light period is intermediate or short in length. The wheats of the area are characterized by enormous height, leafiness, broad foliage, large spikes and large kernels. Their spikes resemble those of Mediterranean forms. They are distinguished by great productivity, resistance to leaf rust, and exceptionally tall stalks. The standard Azerbaijan type is Apulukum 077 hard winter wheat, one of the most productive types of wheat; when grown under favorable conditions in Azerbaijan, it excels even Mediterranean forms. Among these, as an admixture, grow soft wheats, which in compactness of spike and form of lemma rather resemble hard wheats.

The barleys of this region are characterized by late maturation. Winter forms are usually grown, with a large kernel and large spike. As a whole, the region is characterized by exceptionally productive wheat and barley types which have evolved under mild climatic conditions and have a long growth period. As a result of the beneficent action of the sea, the wheats and the barleys as a rule, despite the dry summer, do not suffer from dry winds. The local barleys are characterized by an exceptional resistance to grain damage by the Swedish fly, which under local conditions inflicts grave damage on representatives of other agroecological groups. The character of the varieties of this area is completely different from that of any other area of the globe, constituting a unique historically evolved ecotype.

12. Apsheron Semi-Desert Region

The most arid area within the Transcaucasian boundaries is the Apsheron Peninsula and adjacent territories with an average annual rainfall of approximately 180 mm, occurring mainly in autumn and winter. Climatic indices for the region are presented in Table 13.

In conjunction with the high degree of aridity of the Apsheron Peninsula, peculiar types of winter wheats and barleys evolve, characterized by speed maturation and exceptional resistance to drought. The fact that the rainfall occurs in the autumn and winter and the comparatively mild climate make it possible to raise rapidly maturing cereals without watering. The wheats of Apsheron are characterized by resistance to soil dryness.

In contrast to the low-lying parts of Azerbaijan and Daghestan, Apsheron wheats and barleys are characterized by low height, thin straw, narrow blade, small kernels, small ears, and resemble in appearance Central Asian wheats and barleys but with a sturdier straw and a greater degree of resistance to leaf rust.

13. Talysh Moist Subtropical Agroecological region (Including Lenkoran and Astra Regions as well as the Astrabad, Mazanderan and Ghilan Provinces of Northern Iran)

The Lenkoran and Astarian areas comprising the southern shore of the Caspian Sea have a climate, soil conditions, and vegetation which place them in one common region with the northern provinces of Iran, Ghilan, Astrabad, and Mazanderan. The territory is inhabited by the Talysh, an ethnic group speaking a dialect of the Pharsee tongue. This ecological area differs sharply from the other areas of the Eastern Transcaucasus by possessing a humid, warm climate, markedly arid summers and at the same time high yearly rainfall. Typical climatic data for the Talysh region may be provided by the data of Lenkoran (Table 14).

Table 12
Climatic data for the inadequately humid area of the Caspian

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Derbent, (Dag. ASSR) 42°03' North lat. Elev. 5 m	{ Precipitation (mm).....	26	22	21	27	22	32	22	30	37	36	38	36	
	{ Av. temp. (°C).....	1.6	1.6	4.4	9.6	16.6	21.9	25.0	24.9	20.4	14.8	8.6	1.4	12.5
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—16.4
Makhachkala, (Dag. ASSR) 42°58' North lat. Elev. 32 m	{ Precipitation (mm).....	35	30	28	35	29	41	29	38	47	46	51	48	457
	{ Av. temp. (°C).....	—1.3	0.6	3.7	8.9	16.2	21.4	24.6	24.0	19.2	12.5	6.7	2.4	11.4
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—25.7
Buinaksk, (Dag ASSR) 42°49' North lat. Elev. 475m	{ Precipitation (mm).....	14	18	23	34	58	81	51	60	51	36	22	18	466
	{ Av. temp. (°C).....	—2.5	—0.9	3.3	9.0	16.0	20.3	23.0	22.3	17.0	11.7	4.8	0.8	10.4
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—24.2

Table 13

Climatic data for the Apsheiron semi-desert area

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Baku 40°23' North lat. Elev. 21 m	{ Precipitation (mm).....	19	14	18	19	10	6	4	5	16	24	29	23	187
	{ Av. temp. (°C).....	3.4	4.1	6.4	10.5	17.1	22.0	25.2	25.3	21.5	16.6	10.8	6.7	14.1
Apsheiron, Maiak (near Mardakany), 40°29' North lat.	Precipitation (mm).....	29	16	10	19	13	2	4	7	7	24	25	21	177

Large quantities of tertiary subtropical forest vegetation have been preserved, represented by wonderful endemes such as the Lenkoran silk tree (Albizia julibrissin), the iron tree, (Parrotia persica), and others. The sowing of cereals is carried out chiefly in the autumn. Winter is mild, and for this reason it is possible to sow spring cereals in the autumn. The sowing of so-called English wheat — Triticum turgidum — is encountered with comparative frequency, as well as late spring and hard winter wheats, broad beans — Vicia faba — and winter forms of barleys.

At the beginning of the 20th century, emigrants from Russia to the Astrabad province of Iran introduced large numbers of soft wheats, here thickly contaminated by poisonous weeds such as the darnel (Lolium temulentum L.) and in addition infected with Fusarium, as a result of which the bread of the Astrabad province, specially when warmed, is characterized by powerful toxicity.

143 A typical characteristic of Lenkoran and the adjacent areas is the spread of creeping forms of flax, sown from the autumn on. These are typical winter forms reacting sharply to yarovization. Rice is grown in large quantities in the low-lying areas on irrigated land.

Table 14

Climatic data for the Talysh humid sub-tropical
agroecological area (Lenkoran, Az. SSR)
38°44' N. lat. Elev. 19 m

Data	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Precipitation (mm).....	78	82	95	49	30	27	16	61	168	236	166	116	1124
Av. temp. (°C).....	3.0	4.4	7.1	11.9	18.5	23.2	25.5	25.2	21.2	16.2	10.6	6.1	14.4
Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—15.2

144

14. Zuvand Mountain Region (Near Iran)

The Zuvand Mountain Area borders Lenkoran on its east and to the south is a kind of extension of the Iran Plateau, projecting into the borders of the Azerbaijan SSR. As opposed to Lenkoran, Zuvand is characterized by a comparatively dry climate despite the considerable elevation (up to 1,200 - 2,000 meters). The cultivation of cereals is here predominantly non-irrigated, but irrigated sown areas also exist. The cultivated plant types reflect the marked influence of North-eastern Iran on the one hand, and Armenia on the other. Here mainly spring forms are cultivated. Together with common and club wheats, we meet, from time to time, areas sown with typical Armenian two-grained forms. The wheats are sown both in pure form and mixed particularly with soft wheats. A typical property of the cereals of Zuvand is their relative drought resistance and speedy maturation. Leguminous crops are represented by peculiar forms of grass peas and lentils resembling typical Irano-Turkestan forms. As a whole, the Zuvand shows clearly the influence of the Iranian plateaus and undoubtedly constitutes an individual agroecological area.

Table 15
Climatic data for the foothill and mountain humid areas of the North Caucasus

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Maikop 44°36' North lat. Elev. 230 m	Precipitation (mm).....	34	40	40	58	76	81	66	50	60	45	61	49	660
	Av. temp. (°C).....	-2.0	0.2	5.4	10.0	15.8	19.3	22.2	21.8	16.9	12.1	5.4	1.4	10.7
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-30.6
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	217
Piatigorsk 44°03' North lat. Elev. 498 m	Precipitation (mm).....	13	15	21	40	83	94	71	60	42	29	28	18	514
	Av. temp. (°C).....	-4.8	-2.9	1.7	7.6	14.5	18.6	21.8	21.0	15.4	9.7	2.5	-1.6	8.6
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-30.6
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	217
Prokhladnaya 43°47' North lat. Elev. 243 m	Precipitation (mm).....	12	14	20	37	74	87	54	45	30	29	24	18	444
	Av. temp. (°C).....	-5.2	3.3	2.0	8.7	15.6	20.2	23.0	22.5	16.2	10.6	2.7	-2.2	9.8
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	222
Mosdok 43°45' North lat. Elev. 135 m	Precipitation (mm).....	19	20	28	38	67	80	53	40	33	28	35	30	471
	Av. temp. (°C).....	-3.7	-3.1	2.2	9.6	16.6	21.1	24.2	23.2	17.8	11.2	4.0	-1.2	10.2
Groznyi 43°19' North lat. Elev. 134 m	Precipitation (mm).....	21	25	25	48	70	77	62	53	43	31	22	26	503
	Av. temp. (°C).....	-4.9	-1.4	3.3	9.5	16.7	21.0	23.9	23.4	17.6	11.5	3.8	-1.1	10.2
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-32.4
Nalchik 43°27' North lat. Elev. 513 m	Precipitation (mm).....	13	15	21	42	123	122	80	70	35	38	30	17	606
	Av. temp. (°C).....	-4.5	-2.9	1.9	7.8	14.5	18.5	21.4	20.6	15.4	9.9	2.9	-1.2	8.7
Ordzhonikidze (North Osetia) 43°02' N. lat. Elev. 679 m	Precipitation (mm).....	24	26	38	79	141	163	112	75	76	51	34	26	815
	Av. temp. (°C).....	-4.4	-2.6	2.4	8.0	14.1	17.6	20.4	19.7	14.8	9.7	2.9	-1.4	8.1
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-27.7

The composition of the cultivated flora of the Zuvand area resembles that of the Akhtinski Mountain area of Southern Daghestan, as concerns both cereals and leguminous seed crops.

15. Foothill and Mountain Moist Regions of Northern Caucasus

This includes the foothill and mountainous areas of the Krasnodar district, the Adygei ASSR, Kabarda, Northern Osetia, the Grozny Region and the northern foothill areas of Daghestan. This whole agroecological region is characterized by relatively favorable conditions of wintering, rich chernozem soils and sufficient and sometimes excessive rainfall.

Table 15 gives typical climatic data for this agroecological region. Unfortunately, detailed data for a prolonged period do not exist for the higher mountain regions.

The predominant crops of the foothill and mountain areas of the Northern Caucasus are winter wheat, winter barley and corn. Up to 900 meters, corn is particularly widespread, and at higher altitudes, wheat. In the higher altitude regions, winter wheat is beginning to be replaced by the spring forms. The lower zone is particularly favorable for the cultivation of corn, which here produces maximal yields of grain, averaging twice as high as the average figure for the yield of corn in the Soviet Union. These are the optimal areas for the growth of corn in the USSR. Of the soft winter wheats, Ukrainka and Kosso Briukhovka grow here. As a result of the usual infection of winter wheat by brown and yellow rust, resistant hybrid types grown by the Kashodar Experimental Station have begun to be propagated in recent years. Widespread standard types are Stavropolka and Erythrospermum 0328, hybrids of local types with Canadian Marquis spring type, such as Ferugineum, G-622, and G-622/2. In the course of natural and artificial selection, local forms of winter barley exceptionally resistant to winter conditions have come to stand out, constituting unrivalled ultimate standards for winter conditions anywhere in the world. In the Mosdok area, we found a six-sided winter
147 barley, Hordium hexastichum var. parallelum Körn, with a strong stalk. Together with the local winter barleys, the local soft wheats of the Banat type are of special interest.

The Skalisteeyi and Bokovi Mountain Ranges, as pointed out above, have a pronounced effect on the climate of the intrazonal localities enclosed between the ranges. Thus, in Uch-Kulan, at the foot of Mount Elbrus, the amount of rainfall does not exceed 340 mm. The same phenomenon is observed in the Baksan, Chegem and other ravines of Kabarda, in the Urukh and other ravines of Northern Osetia. Accordingly, in this intrazone band we meet different cultivated ecotypes. Wild flora is here represented quite often by feather grass (Stipa pulcherrima C. Koch), fescue (Festuca sulcata L.), beard grass (Andropogon ischaemum L.), xerophytic shrubs (barberry) (Berberis vulgaris L.), (Spiraea hypericifolia L.), etc. The sown areas are frequently under irrigation. Thus, the ecotype of the cultivated types is here distinguished from the comparatively hydrophilic and mesophilic forms of Cis-Caucasus. The spring wheats in the mountain areas of the Northern Caucasus are represented chiefly by the variety Triticum vulgare gr. persicoides, whose ear structure resembles that of T. persicum. Less often we meet awned spring wheats of the Rusak type. T. persicum occasionally occurs in the high mountain areas of the Kabardia ASSR. Barleys in the mountain areas are usually both two-rowed and four-rowed. The two-rowed forms resemble the Colchichum and Pioneer type.

Central Asia (In a Broad Geographical Sense)

16. Iran-Turkestan Agroecological Region

The large territory of Soviet Central Asia and the contiguous parts of Iran, Northern Afghanistan and Sinkiang, as well as the adjacent dry low-lying foothill areas of Kirgizia and Kazakhstan may, as shown by direct research on the cultivated plant flora and the cultivation conditions, be grouped into a single Irano-Turkestan agroecological region. Characteristic features of the region are an exceptionally dry climate (the rainfall occurs in late autumn, winter and spring) and a hot summer.

Agriculture is associated with the mountainous regions and river basins and is overwhelmingly of the irrigated type. The breadth of the region and its mountainous nature obviously occasion a variety of climates, but nevertheless the grassy or herbaceous cultivated flora has such pronouncedly common traits under the influence of the dry climate and the cold winter that it may be placed into a single group. In conformity with the varied conditions existing within the limits of the Irano-Turkestan agroecological region, we distinguish the following agroecological areas:

16a. - Foothill and mountainous regions of drylands with a sufficient water supply with a predominance of non-irrigated cultivation.

16b: - Foothill and mountainous regions of drylands with an insufficient water supply, where despite the existence of non-irrigated agriculture, the sown areas are generally subject to the fatal action of drought.

16c. - Foothill and mountainous regions with irrigated culture.

16d. - Khiva Oasis and the lower reaches of the Amu-Dari River, (including Kara-Alpakia and the areas belonging administratively to Uzbekistan), with irrigated culture.

16e. - Oases of Sinkiang (Kashgar, Yarkand, Khotan, Uch, Turfan, etc.).

148 In view of the great influence of the direction of the slopes and local effects, conditions here vary greatly from the point of view of the quantity of rainfall, and thus, areas such as these arise which are not always sharply separated geographically; one and the same ecotype is to be met within various localities sometimes very remote from one another, in accordance with the similarity of conditions. For this reason, the term "ecological area" in such cases does not always possess a definite geographical identity.

The higher altitude areas of Central Asia, Afghanistan and Western China are as a rule characterized by a decrease in the amount of rainfall as the elevation increases. Accordingly, irrigated agriculture is the predominant type here. Only occasionally on the Hindu Kush in Afghanistan do we encounter stretches of non-irrigated agriculture. On the whole the amount of rainfall characteristic of the Irano-Turkestan region is very small, varying from 60 to 400 mm per year, occurring in November, December, January, February, March and April. The summer is extremely dry. The sowing of cereals takes place as a rule in the autumn or around winter, and in the mountain areas, usually in spring. As a whole the climate of the Iran-Turkestan region is a continental one. The winters in the foothill and mountain areas are comparatively mild, permitting the growth of winter wheat. The summer is hot, quite sufficiently so for the ripening of cotton. Here corn under irrigated conditions suffers no drought, and should be sown as late as possible.

Under the particular conditions of the semi-desert climate of the Iran-Turkestan Region, there evolved in the course of millenia extremely drought-resistant types standing up particularly well to summer atmospheric dryness. The most markedly drought-resistant types of wheat, barley and leguminous seed crops are peculiar precisely to the areas of sufficient and insufficient water supply of Iran, Northern Afghanistan and Soviet Central Asia. Characteristic features of the wheats, barley and field weed-rye of Central Asia, Interior Iran, and Northern Afghanistan are the coarseness of all the plant elements, particularly the ear, the poor threshability of the grain usually tightly enclosed in the scales, and the coarse, brittle beards. As a rule, the local cereal types are characterized by speedy maturation and large demands for warmth in the later phases of development. Depending on the different heights of cultivation and different temperature conditions, differences in the growth periods are observed. In general, the longer growing periods are typical of types found in low-lying irrigated areas. Under European conditions, the Central Asian types are usually exceptionally susceptible to infestation by rust, smut, and powdery mildew. The dry air of the Iran-Turkestan region does not favor the development of ectoparasites, as a result of which natural selection here produces no immunity. Hence the exceptional vulnerability under the conditions favoring infection in the steppe, forest-steppe and forest areas of the Soviet Union. A defect of local sorts of the Iran-Turkestan region plants when placed under forest, forest-steppe and steppe zone conditions of the European part of the Soviet Union, is their exceptionally fragile, recumbent and brittle stalk. In the high mountain areas, forms comparatively resistant to cold evolved, for example, the wheats of Afghanistan and naked six-rowed barleys and peas. Leguminous seeds and flax of the Iran-Turkestan region as a whole are characterized by small grain, which in this respect only slightly exceeds the local types of India and the areas of Southeastern Afghanistan. In the high mountain areas of the Iran-Turkestan Region, where irrigation is used, special mesophile types developed differing sharply from the usual xerophile forms of non-irrigated areas. The hull-less six-rowed barleys of the high mountain areas of Afghanistan, Soviet Central Asia and Sinkiang are characterized by broad blades. The spring rye of the Pamir is characterized by gigantism, wide blades and large grain (Figure 71).

The wheats of the high mountain areas are also markedly varied. Endemic non-ligulate forms have been discovered among them. On the whole a peculiar type of mesophile cultivated plants has evolved which, although having a comparatively coarse ear, still disperses more readily than typical Central Asian forms of foothill and mountainous irrigated and non-irrigated areas.

We pass on to an examination of the conditions characteristic of the individual areas of the Iran-Turkestan agroecological region.

16a. Foothill and Mountain Regions of Drylands with a Sufficient Water Supply

The annual amount of rainfall varies from 350 to 400 mm. As an example of an area of adequate water supply we may take that of the Krasnovodopad Station located to the north of Tashkent, and partly also the Tashkent areas of Uzbekistan itself (Table 16).

As we see, the rainfall occurs principally in the spring, winter and autumn periods, the summer being exceedingly dry. Wheat is represented chiefly by soft forms of the speltiforme type, with scales and general spike morphology resembling that of T. spelta - the true spelt. The chief part of the watered area is located in



Iran. Valley landscape



Tadzhik SSR. Valley of the Sur-khab River on the Garm-Novobad road. Photograph by A.S. Tuz



Valley of Shakhimardan, Alai Range. Photograph by
Fergana Expedition



Mountain gardens of the village of Bogustan along the
Iskem River in the Talas Ala-tu, 1,100 meters above
sea level. Photograph by N.V. Kovalev

- 151 the Khurasan province of Iran. Large areas of watered soils occur in Northern Afghanistan where they run into hundreds of thousands of hectares*. Large areas are occupied by irrigated crops in the Herat, Meimana, and Turkestan provinces of Afghanistan. Within the boundaries of Soviet Central Asia, areas of irrigated crops adjoin Kopat-Dagu (Turkmenia) and Central and Southern Tagikistan. In Uzbekistan they are concentrated around Tashkent and Katta-Kurgan. Usually irrigated dryland sown areas, as it were, surround irrigated oases, and are located mainly on the slopes of mountains.



FIGURE 71. Field weed rye - Secale cereale. Long-eared form, Pamir.

* N.I. Vavilov and D.D. Bukinich. Agricultural Afghanistan. 1949.

Table 16

Climatic data for the foothill and mountain areas of assured water supply

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Krasnyi Vodopad [Red Waterfall] 40°57' North lat. Elev. 603m	Precipitation (mm).....	48	54	72	74	34	12	4	0	6	30	33	39	406
	Av. temp. (°C).....	-2.1	1.8	7.5	14.5	20.2	25.0	28.1	26.6	20.9	13.5	7.7	2.7	13.9
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-25.8
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	265
Tashkent 41°20' North lat. Elev. 479 m	Precipitation (mm).....	45	37	63	51	29	12	3	1	5	26	34	42	348
	Av. temp. (°C).....	-0.3	1.9	7.2	14.8	20.7	25.5	27.4	25.3	19.3	12.4	6.9	2.2	13.7
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-28.1

Table 17

Climatic data for foothill and mountain areas without assured water supply

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Kushka 35°17' North lat. Elev. 630 m	Precipitation (mm).....	40	42	60	30	12	2	0	0	1	9	25	25	246
	Av. temp. (°C).....	1.5	3.8	9.4	15.0	21.0	25.4	28.0	25.7	20.1	14.1	8.2	4.2	14.7
	Av. abs. annual temp. min (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-20
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-33
Teheran 35°41' North lat. Elev. 1,160 m	Precipitation (mm).....	46	28	48	36	13	2	1	1	1	9	32	34	251
	Av. temp. (°C).....	0.9	5.7	8.9	16.3	21.8	26.7	29.4	28.4	25.4	18.8	10.7	5.4	16.5
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-12.9

16b. Foothill and Mountain Regions of Drylands with an Insufficient Water Supply

The annual amount of rainfall here is usually 250-350 mm, also occurring predominantly in the autumn, winter and early spring. Summer is extremely dry. Sowing is conducted from autumn almost until winter and often very early in spring (January-February). Typical climatic data may be provided by those for the area of Kushka (Southern Turkmenia) (Table 17).

153 Here, under conditions where supplied water was not assured, there evolved forms of wheat and barley exceptionally resistant to drought, distinguished by swift maturation, rapid initial growth, slight bushiness, medium or low height. The wheats and barleys of this region are as a rule represented chiefly by spring forms reacting weakly to irrigation, and under sufficiently humid conditions quite exceptionally vulnerable to rust and powdery mildew. A characteristic peculiarity of the wheat when transferred into European steppe, forest-steppe or forest zone conditions is exceeding proneness to recline, as is also typical of the cereals of the earlier mentioned areas. Wheats and barleys are represented by characteristic coarse-eared forms of the rigidum type (Figures 72 - 78).

154 In addition to the areas of sufficient and insufficient water supply, we distinguish in Central Asia a zone of semi-sufficient water, characterized by intermediate or transitory types of varieties. The geographical zone of insufficient water supply adjoins the zone of sufficient water supply.



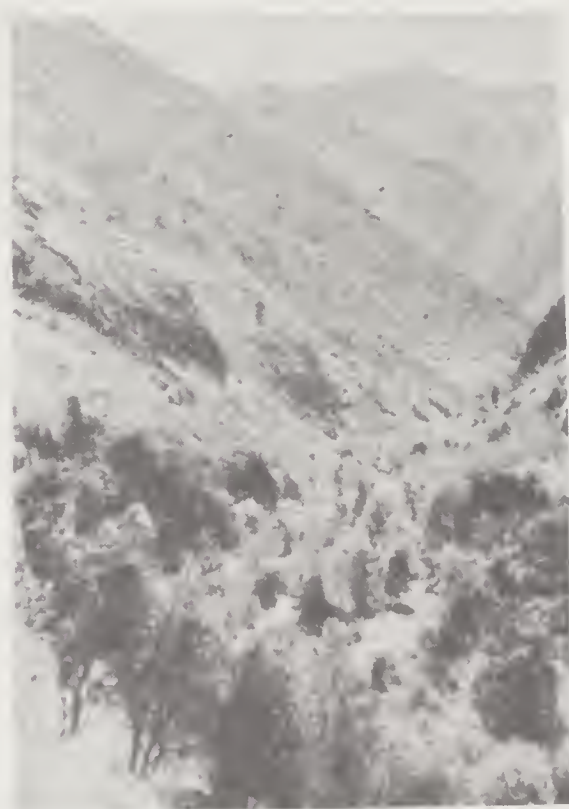
FIGURE 72. Soft wheat - Triticum vulgare Vill. Afghanistan, area of Harat



FIGURE 73. Soft wheat-
Triticum vulgare Vill.
Afghanistan, Khezari Road



Tadzhik SSR. Wood of walnut in the
Vanch River valley. Photograph by .
A. V. Gurskiĭ



Upper reaches of Ispaisai, 1,700
meters above sea level. Upper
limit of wood vegetation.
Photograph by N. V. Kovalev



Tadzhik SSR. Nut-pear forest in the Vanch River valley. Photograph by A. V. Gurskiĭ



Tadzhik SSR. Kishlak of Kuf in the Rushan area. Sheaves of pressed wheat. Photograph by A. V. Gurskiĭ

16c. Foothill and Mountain Regions of Irrigated Crops

The irrigated areas of agriculture in Soviet Central Asia, Iran, Afghanistan and Sinkiang (Western China) are located in oases in the vicinity of rivers, or at the foot of mountains. The agriculture of Iran, Afghanistan and Central Asia is represented principally by irrigated cultivation. This includes large sown areas of the Ferghana Valley, the Samarkand and Tashkent Oases, the lower reaches of the Amu-dar'ya, the Ashkhabad, Merv, and Tedzhen Oases, the irrigated areas of Interior Iran and Northern Afghanistan, irrigated areas along the Hari River (the large Herat Oases), and a considerable irrigated area near Mazar-i-Sherif, Balkh and Murgab. Agriculture in Sinkiang is represented exclusively by irrigated oasis cultivation. All the areas examined here are characterized by dry hot summers, the amount of rainfall averaging 100 - 300 mm. occurring mainly in the autumn, winter and spring. The sowing of cereals — wheat and barley — is carried out here principally in the autumn and rarely in early spring.



FIGURE 74. Soft wheat — Triticum vulgare Vill.
Afghanistan, upper reaches
of Kabul River



FIGURE 75. Soft wheat — Triticum vulgare Vill., rigid form; Central
Asia

Leguminous seed crops (Figure 81-84) and flax (Figures 85-86) are sown in early spring. The soils of the areas considered are predominantly "light-yellow earths" (zheltozem), serozems (grey earths), light-brown, and, less often, red-brown soils characteristic of desert-steppe regions. Summer is torrid, and cultivation without irrigation is, as a rule, practically impossible in many areas.

We present the climatic data for typical oases in Uzbekistan, Turkmenia and Iran in Table 18.



FIGURE 76. Soft wheat—Triticum vulgare, Vill. Bukhara

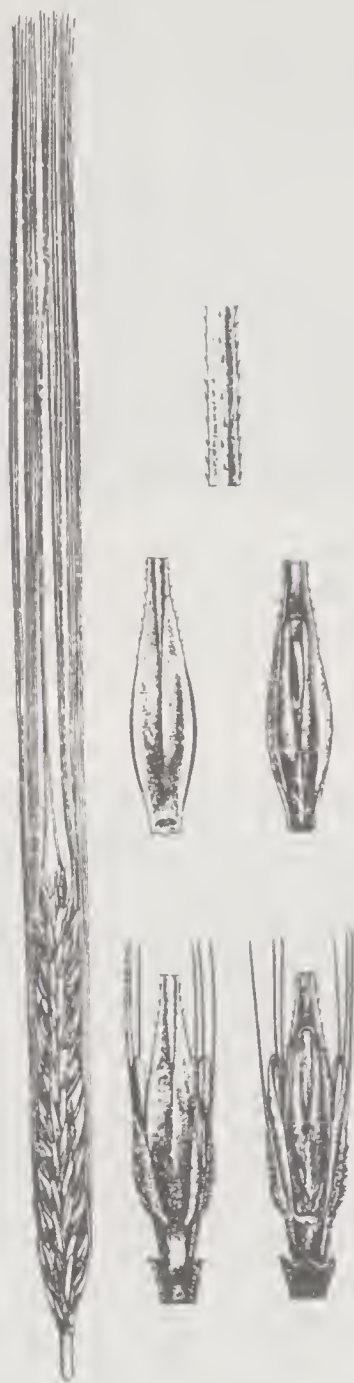


FIGURE 77. Wild grain barley—Hordeum spontaneum C. Koch, ear and its parts, Central Asia



FIGURE 78. Barley—Hordeum distichon, L. nutans, Schübl Afghanistan



Tadzhik SSR. Ancient river terraces on the right bank of the Gunt River, at junction with Shakh dara River. On terraces are fields, gardens and villages.

Photograph by A. V. Gurskiĭ



Tadzhik SSR. Remains of nut forests in the Vanch River valley. In the distance are canals bringing water from the mountains. Photograph by A. V. Gurskiĭ



Tadzhik SSR. Method of packing hay on roofs of animal buildings in mountain areas. Photograph by A. V. Gurskiĭ



Tadzhik SSR. Apricot tree among fields of wheat in the valley of the River Gunt. Photograph by A. V. Gurskiĭ



FIGURE 79. Field weed-rye - Secale cereale L., Brittle and semi-brittle forms, Afghanistan



FIGURE 80. Field weed-rye - Secale cereale L., Non-brittle forms, Afghanistan



FIGURE 81. Sown peas - Pisum sativum L., Iran

Climatic data for foothill and mountain areas of irrigated cultivation

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Samarkand Uzbekistan , 39°39' North lat. Elev. 720 m	Precipitation (mm).....	36	30	59	70	34	7	4	1	1	19	22	32	315
	Av. temp. (°C).....	-0.2	2.4	7.8	13.8	19.0	23.4	24.8	23.1	18.5	11.9	7.4	3.1	12.9
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-23.7
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	271
Fergana Uzbekistan , 40°23' North lat. Elev. 578 m	Precipitation (mm).....	21	15	27	19	21	11	5	2	3	12	18	20	174
	Av. temp. (°C).....	-2.7	0.2	7.5	15.2	20.4	24.5	26.4	24.8	19.0	11.8	5.4	0.6	12.8
	Av. abs. annual temp. min. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-
	Min. temp(°C)	-	-	-	-	-	-	-	-	-	-	-	-	18.2
Andizhan Uzbekistan , 40°47' North lat. Elev. 501 m	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	-27°
	Precipitation (mm).....	27	22	38	24	22	10	6	2	2	19	17	20	209
	Av. temp. (°C).....	-2.4	0.0	7.8	15.3	20.6	24.9	26.3	24.5	19.8	12.3	6.0	0.8	13.0
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-25.4
Bairam-Ali Turkmenia , 37°20' North lat. Elev. 277 m	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	25.7
	Precipitation (mm).....	17	19	29	22	8	2	0	0	0	5	9	13	124
	Av. temp. (°C).....	0.3	3.7	10.0	17.0	23.6	28.4	29.8	28.0	22.2	14.8	8.7	3.8	15.9
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-25.6
Termez Uzbekistan , 37°12' North lat. Elev. 302 m	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	288
	Precipitation (mm).....	18	15	29	18	12	0	0	0	0	5	8	14	119
	Av. temp. (°C).....	1.7	5.0	11.2	18.1	25.0	29.8	31.5	29.5	23.7	17.0	10.5	6.1	17.3
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-25.3
Izfakhan Iran , 32°38' North lat.	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	306
	Precipitation (mm).....	19	13	32	16	11	0	0	0	0	6	20	18	130
	Av. temp. (°C).....	0.2	5.3	8.4	15.6	20.7	25.2	27.8	25.6	22.4	16.1	9.1	4.7	15.2
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-20.1
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	304

Despite the extremely large territory on which irrigated agriculture is distributed in oases in Central Asia, Iran, Afghanistan and Sinkiang, as a whole it is represented by a single type of coarse-eared forms of soft and dwarf wheat, barley and field-weed rye. Flaxes are represented here predominantly by small-sized small-seed bushy types. The leguminous seed crops of small or medium-sized seeds are comparatively resistant to drought. In addition, all types peculiar to irrigated oases of the Iran-Turkestan region are distinguished by a positive reaction to irrigation.

163



FIGURE 82. Chick pea - Cicer arietinum L., Uzbek SSR



FIGURE 83. Chick pea - Cicer arietinum L., Iran

16d. Khiva Oasis

The Khorezm Agricultural Area is associated with the lower reaches of the Amu-Dari River and is characterized by peculiar properties. Agriculture is carried on exclusively by means of irrigation or the estuary type of cultivation. In spring, there is usually a lack of water as a result of the delayed arrival of water from the upper reaches of the Amu-Dari River. This phenomenon is a highly material one for this particular oasis and accordingly there evolved a peculiar eco-type with initially delayed development and a long first stage of development.

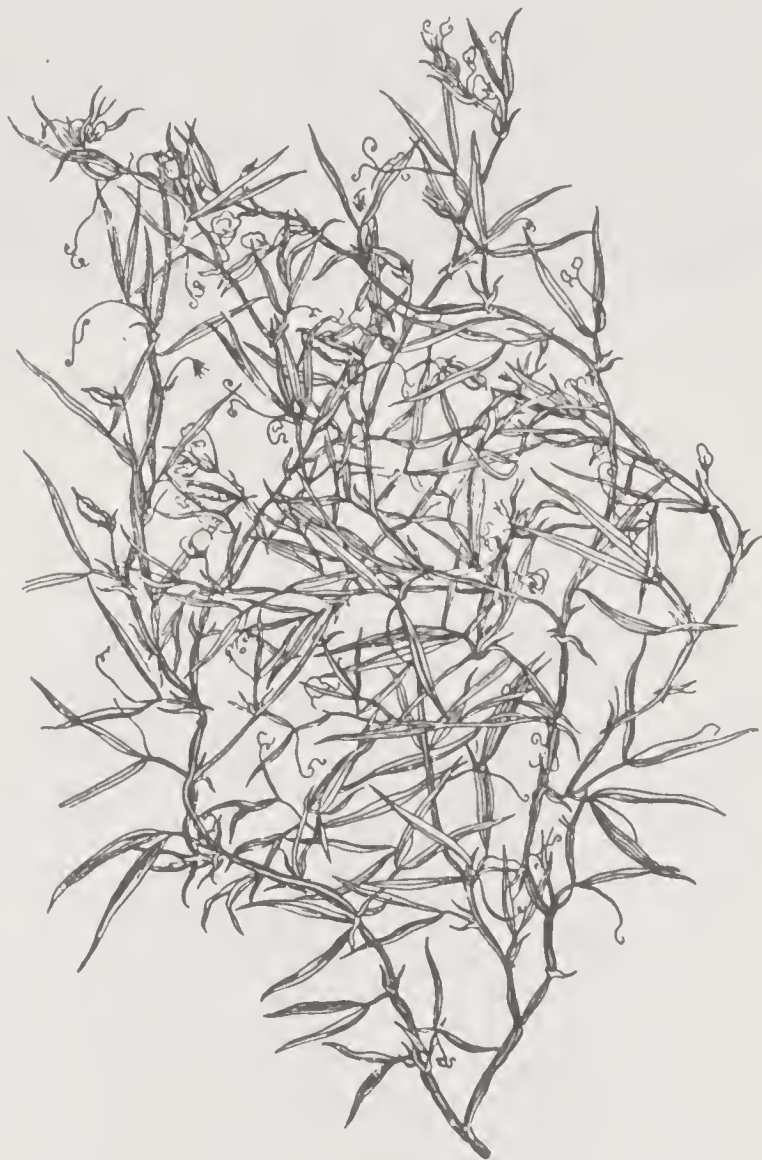


FIGURE 84. Cultivated grass pea (chickling vetch) - Lathyrus sativus L., Uzbek SSR

The rainfalls occur principally in the spring, autumn and winter.

The geographical isolation of the Khivian Oasis, which is separated from the principal agricultural areas of Central Asia by the Kara-kum and Kyzyl-kum Deserts, favored the development of peculiar recessive forms of white-blossomed and white-seed flaxes, and original late-blossoming and white forms of peas; soft and dwarf wheats are represented here by small-seed, low-height rapidly maturing winter and



FIGURE 85. Flax - Linum usitatissimum L., Afghanistan

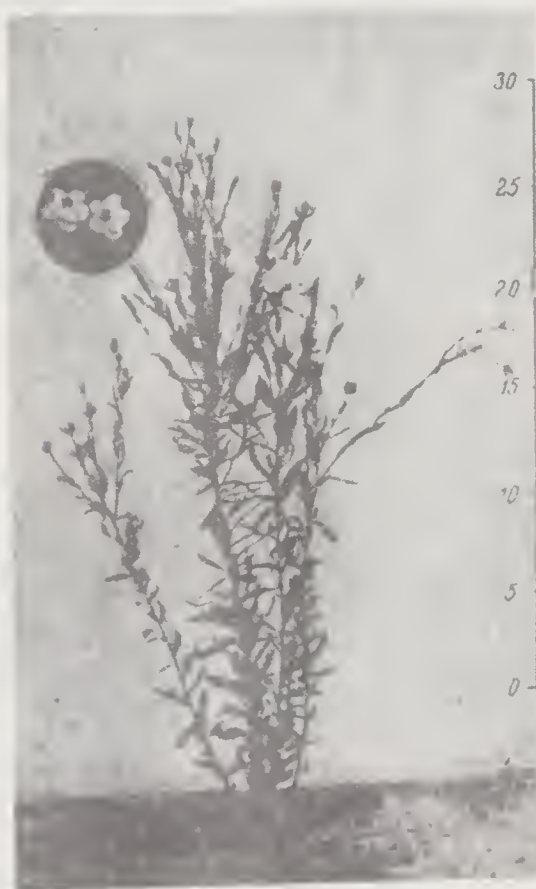


FIGURE 86. Flax - Linum usitatissimum L., Afghanistan, Shibirghan

167

spring forms, comparatively resistant to cold, with a slender stalk and narrow leaves. The winter forms are characterized at the beginning of their development by a spreading growth. The flaxes and peas of Khiva are distinguished by exceptionally late maturation constituting extreme variants for these particular plants. The vernalization stages of these forms are extremely long. In general, the coarse-eared property and the fact that the grain of wheat of the Khivian oasis is not dispersed readily bring it close to the local foothill and mountain wheats of Central Asia.

16e. Oases of Western China (Sinkiang)

Under the severe conditions of Sinkiang (Kashgaria), in areas located over 1,000 metres above sea-level, under conditions of exceptional geographical isolation, in oases surrounded by the gigantic ranges of the Himalayas, the Kuenlun, and the Pamirs, and east of the deserts of the Takla-Makan, peculiar cultivated forms of cereals and other plants have evolved. The winter wheats of the oases of Kashgar, Yarkand, Khotan Ukh-Turfan are distinguished by speedy development at the beginning of growth, considerable resistance to cold, and a comparatively short vernalization stage. The amount of rainfall here does not exceed 100 mm, and this occurs principally in the spring months.

Table 19 presents climatic data for the largest oases of Sinkiang-Kashgar.

Table 19

Climatic data for the point Kashgar,
(39°29' North lat. Elev. 1230 m)

Data	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	X	XII	
Precipitation (mm)....	5	5	15	20	25	5	5	0	15	0	0	5	100
Av. temp. (°C)	-5.8	0.1	8.4	17.3	19.2	24.2	27.5	25.7	19.2	12.3	3.5	-2.7	12.4
Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	241

The climatic figures for other points of this agroecological region are the following:

Yarkand (Kashgaria), 38° 15' North latitude

Height above sea level (meters)	1,255
Temperature of warmest month (°C)	27.6
Temperature of coldest month (°C)	- 6.0
Number of days with temperature above +5°C	239

Urumchi (Western China), 43° 52' North latitude

Height above sea level (meters)	887
Temperature of warmest month (°C)	22.6
Temperature of coldest month (°C)	-15.3
Number of days per year with temperature above +5° C	194
Annual rainfall (mm)	98 mm

The soils are loess soils, deep and comparatively fertile. The unfavorable agricultural conditions in Kashgar (torrid, dry summer, short growth period, insufficiency of irrigation water) evolved peculiar types very resistant to drought, particularly in the later stages of development. Thanks to the dry air, rust here is almost completely unknown, as a result of which the wheats of Kashgar, when placed under normal conditions of the steppe, forest-steppe and forest zones of the European part of the Soviet Union, are severely affected by brown and yellow rusts. The



FIGURE 87. Flax - Linum usitatissimum L., Late, high, China, Sinkiang

spikes and awns of the wheats and barleys of Kashgaria are less coarse than those of the oases of Central Asia and Iran. The leguminous seed crops, as well as the cereals of Kashgaria, are characterized by swiftly maturing types. In the areas of Kashgar, Yarkand and particularly Turfan, there have been discovered the most rapidly maturing cotton plants in the world, both of the Indian type (Gossypium herbaceum) and that of the American uplands (G. hirsutum).

- 171 Isolated from Central Asia by mountain chains, from China by wide deserts, and from the south by the barrier of the Himalayas, the Kashgar, Yarkand, Khotan, Ukh-Turfan and other oases of Kashgar are characterized by unique recessive forms of white-blossomed white-seed narrow-leaf flaxes, little resembling the usual Central Asian or European forms of flax (Figure 87). Here we also find peculiar recessive forms of peas and chick-pea, which are probably connected with the results of inbreeding (isolation of recessives).



Kashgar. Bullocks harnessed to local implement for cultivating fields



Kashgar. Vegetable bazaar



Afghanistan. Types of inhabitants



Afghanistan. Family of nomadic Maldars near the Bakvi desert along the Kosh-Dari River (not far from Sultan Bakv)

17. Agroecological Region Near the City of Kabul

The capital of Afghanistan-Kabul is located at a height of 1,900 meters above sea level, placed at the center of a large agricultural oasis with sown areas ascending to 2,200 meters above sea level. Lying between the Hindu-Kush and the Suleiman Mountains, the Kabul agricultural area shows the effects of the Iran-Turkestan agroecological region, but at the same time reflects to a considerable extent its link with Northern India. The soils of the Kabul oasis are usually fine alluvial soils often created artificially as the result of a great deal of labor. The maximum amount of rainfall occurs in the winter and spring periods. The summer is dry and burning hot. Thanks to the location on the southern slopes winter is comparatively mild, the absolute minimum dropping no lower than -20°. Here, wheats are principally represented by winter forms. Barleys and leguminous crops are sown in spring. The mild climate makes sowing in very early spring possible.

We present the climatic data for Kabul, which are characteristic of the entire Kabul Oasis (Table 20).

The classification of this oasis as an independent agroecological region is occasioned not only by the fact that it is situated on the southern slope of the Hindu-Kush, but also by the peculiar cultivated flora of original types unknown in other countries of the world. The Kabul area stands out distinctly by virtue of its peculiar dwarf winter wheat, characterized by a comparatively strong stalk and a short

Table 20

Climatic data for point Kabul, 34°32' North lat. Elev. 1900 m

Data	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Precipitation (mm)	26	21	119	55	16	5	5	4	0	3	26	6	286
Av. temp. (°C)	-0.7	2.1	8.2	14.2	20.0	22.9	24.8	24.2	20.4	14.6	10.4	4.7	13.8
Abs. min. temp (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-17.9

172 flat spike which is difficult to thresh. This is, as it were, the extreme type of the coarse-ear club wheats. Among the Kabul dwarf and soft wheats we often encounter forms comparatively resistant to brown and yellow rusts, differing sharply in this respect from the especially vulnerable forms of Central Asia. Here the Afghan dwarf wheats, which constitute a special group, are represented by a large and varied assortment of species. No less unique are the leguminous seed crops such as grass peas, peas and lentils, which are, for the most part, small-seed types, dark in color and often extremely variable in the size of seed. As a whole, the Kabul agroecological region represents, as it were, the interaction of the influences of the Iran-Turkestan Region and of Northern India.

18. High-Mountain Central-Asiatic Agroecological Region

A typical feature of the high mountain parts of Central Asia is the high altitude level above sea at which agriculture is practiced, sometimes ascending to 4,600 meters. In Tibet, within the borders of Afghanistan, on the Hindu-Kush, agriculture rises to a height of 3,400 meters. As shown by the experiments conducted by the Pamir Biological Station (P.A. Baranov and I.A. Rukova), a number of crops, such as barley, tubers and potato, ripens here at a height of up to 3,900 meters.



FIGURE 88. Naked-grain barley - *Hordeum vulgare* L., var. *coeleste* L., Pamir

In the Central Asiatic High Mountain Agroecological Region we include the agricultural areas found in the high altitude levels of the Hindu-Kush in Afghanistan and the high mountain parts of Tibet, the Himalayas, on the Kuenlun, in Chitral and in Ladakkh, at levels above 2,000 meters. On this vast territory, agriculture is distributed in small oases and, as a result of the extreme dryness of the climate is as a rule of the irrigated type. The growth period of the region is short. The fatal action of low temperatures is often felt in summer months. At night, temperatures below 0° C are observed here even in July. Under the peculiar climatic conditions of the dry high mountains, there are usually no ectoparasites such as rust, powdery mildew, or others.

173

The agriculture is composed mainly of spring forms of barley (Figure 88), rye, leguminous crops, olives, cress, more rarely, flax (Figures 89, 90). From time to time winter forms occur in the agriculture, for example in Afghanistan, where in the areas of Badakhshan and Zebak they are found at up to 2,800 meters. As a whole, this region is characterized by original types. There are large quantities of naked six-row barleys, with a wide, light-colored leaf, sometimes sown in mixtures with leguminous seed crops, such as peas, grass peas, beans. Agriculture here is highly intensive. Every patch of land must be treasured and the fields must be cleaned of stones. Despite the harshness of conditions, agriculture here goes back not only many centuries but several millenia. Accordingly, distinct ecotypes have evolved sharply differentiable from the ecotypes of other agro-ecological regions of the world. Among these is the peculiar giant spring rye of the Pamir-Badakhshan area, which has large pollen and exceedingly large anthers, clearly distinguished from the usual forms of spring and winter rye. Such also are the peculiar forms of naked kernel wide-leafed barleys rapidly maturing type, peculiar recessive forms of non-ligulated soft and club wheats, non-ligulated rye, peculiar fast-maturing forms of cold-resistant peas and blue-flowered grass peas.



FIGURE 89. Flax - Linum usitatissimum L., low height, mountainous Badakhshan Maimana

When transferring types from the high mountains of Central Asia to the conditions of the steppe, forest-steppe and forest zones of the European part of the USSR, they are distinguished, as shown by field experiments, by an exceptional
174 tendency to decumbence and infection by rust, powdery mildew, and Swedish fly, as well as to germination of the grain while on the root during ripening.

Despite the general ecological uniformity here, we may delineate several areas reflecting the influence both of environmental conditions and the historical connection of the population and cultivated flora with nearby closest lower-lying agricultural areas. Within the limites of the high mountain Central Asiatic agro-ecological region, we distinguish four groups of areas:

- 18a. High mountain areas of the Hindu-Kush, Hissar, Turkestan, Alai and Trans-Alai Ranges.
- 18b. Pamir-Bedakhshan high mountain agricultural areas.
- 13c. High mountain agricultural areas of the Himalayas.
- 18d. Agricultural oases of Tibet.



FIGURE 90. Flax - Linum usitatissimum L.,
Mountainous Badakhshan Region of the
Tadzhik SSR

175 18a. High-Mountain Regions of Hindu-Kush and of the Hissar, Turkestan,
Alai and Transalai Mountain Ranges

Here the agricultural oases are located in small isolated spots. Mainly spring varieties are grown, these attaining the most extreme elevations known to agriculture. The areas sown with winter wheat and the contaminating weed rye lie at heights of nearly 2,000 meters on the Hindu-Kush, and quite often rise to 2,600-2,700 meters. Thus, on the road from Northern Afghanistan to Kabul, in the Bamian Valley, there are large sown areas of winter wheat. Farming is represented by wheat, barley, beans, peas, grass peas, Persian clover or "shabdar" (Trifolium resupinatum L.) and lucerne. The fields of winter wheat are usually weed-ridden by field-weed rye. This is the domain of six-row hull-less barleys and of endemic forms of leguminous seed grains: grass peas, peas, beans, mainly with dark-colored small seeds. More rarely we meet fields of flax, colza (Brassica campestris L.), rocket (Eruca sativa Lam.) and lentils reaching a height of 2,800 meters. Levels considerably higher than 2,000 meters are inhabited by the mulberry tree (Morus L.), walnut, (Juglans regia L.), and apricots (Armeniaca vulgaris L.)

According to our research the following mountain zones may be mapped in Afghanistan on the Hindu-Kush, corresponding to a large extent to the zones of the Central Asian mountain ranges: at 3,000-3,500 meters is the zone of hull-less 6-rowed barleys and also hulled 6-rowed barleys, of spring wheat, peas, spring rye, and French lentils (Vicia ervilia Willd.). On the whole, this is predominantly a zone of barley cultivation; 2,500-3,000 meters is a zone of hull-less 6-row barley, hulled six-row barley, spring wheat, peas, beans, grass peas, French lentils (Vicia ervilia), flax, colza, rocket, Persian clover, a zone of spring cereals and leguminous seed crops; 2,000-2,500 is a zone of hulled 6-row barley, winter and spring wheat, winter field-weed rye, peas, beans, lentils, flax, colza, rocket, Persian

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

clover, walnut and mulberry. This zone may be defined as a zone of mulberry, winter cereals, Persian clover, and lucerne. The zone of the maximum variety of cultivated plants and types of plants is usually located below 2,000 meters. Unfortunately, because of the lack of meteorological data, it is impossible to present a detailed climatological description of this region at this time.

18b. Pamir-Badakhshan High-Mountain Agricultural Regions

This includes both the Soviet Badakhshan autonomous administrative region of the Tadzhik SSR, as well as the agricultural areas of Afghan, Badakhshan and partly of western Chitral.

The climatic conditions of the Pamir-Badakhshan area may be judged from the data on the Khorog and the Pamir Station (Table 21).

A characteristic feature of this area is the exceptional aridity of the climate. The average amount of rainfall recorded in the Pamir Station over 24 years does not exceed 59 mm per year. This is a high mountain desert in the fullest sense of the word. Agriculture is possible here only by irrigation. As the elevation rises, the absolute minima fall very low (at the Pamir Post, -46.7°C). Night temperatures during the summer fall to -5°C . Only the existence of unique forms evolved under such conditions of physiological toughening make it possible to grow a few cultivated plants (as shown by research carried out by I.I. Tumanov)*. The typical features of the Pamir climate favor the accumulation by plants of a large amount of sugars in their leaves and stalks. It is possible that this fact endows Pamir plants with their endurance to low temperatures, making it possible for them to endure the frequent falls in temperature at night during the summer to below 0°C .

In addition to the typical most widespread hull-less grained 6-rowed barley, distinguished by rapid maturation and quick development at the beginning of the vegetative period, the Pamir-Badakhshan area is characterized by original soft dwarf wheats, easily threshed and without a coarse ear, among which large numbers of recessive non-ligulated forms have been discovered, the spring rye of the Pamir region, widespread in Shugnan, Roshan, and Afghan Badakhshan being especially noteworthy. It is characterized by an enormous height, large anthers, large pollen, and large grains. Numerous liguleless forms of this plant have been discovered. Here barley is quite often grown in mixtures with peas, grass peas, and beans.

18c. High-Mountain Agricultural Regions of the Himalaya

This includes the farming areas of the high mountain passes of Chitral, Baltistan, and the Ladakh (in the widest meaning of the term). The territory is characterized by a desert climate and high elevation agriculture, succeeding in Ladakh, in the vicinity of Lake Pangong, and in Rupcha, at 4,500 meters above sea level. This is the source of the Indus River. In general, the climate of these territories resembles that of the Pamir-Badakhshan area. Only irrigated agriculture of spring cereals is possible here.

We present typical climatic data for Ladakh:

Keiling, $32^{\circ} 34'$ North latitude

Height above sea level (meters)	3,074
Temperature of the warmest month ($^{\circ}\text{C}$)	16.7
Temperature of the coldest month ($^{\circ}\text{C}$)	-4.7
Absolute temperature minimum	-23.2
Amount of rainfall (mm)	594
Amount of assured rainfall (mm)	269

* I.I. Tumanov. "The physiological basis of the winter resistance of cultivated plants." Moscow-Leningrad, 1940.

Table 21
Climatic data for the Pamir-Badakhshan high mountain agricultural areas

Place	Data	Month												Average
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Khorog, (Tadzhik SSR), 37°29' North lat. Elev. 2,098 m	Precipitation (mm).....	28	21	23	29	18	5	3	1	3	10	22	20	183
	Av. temp. (°C).....	-7.5	-6.1	0.3	9.1	14.7	18.7	22.0	22.0	18.1	10.8	9.8	-3.5	8.6
	Days over +5°C.....	—	—	—	—	—	—	—	—	—	—	—	—	223
Pamir Post, 38°11' North lat. Elev. 3,653 m	Precipitation (mm).....	5	4	8	6	6	11	13	6	2	2	0	1	59
	Av. temp. (°C).....	-17.2	-14.8	-6.8	0.5	5.9	9.9	13.5	13.1	7.8	0.2	-7.3	-5.6	-0.7
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	-46.7
	Days over +5°C.....	—	—	—	—	—	—	—	—	—	—	—	—	198

In their flora of cultivated plants, these areas are also close to the Pamir-Badakhshan area. Large quantities of 6-rowed hull-less barley are encountered, as well as rapidly maturing types of spring wheat, small-seed peas, and horse beans, grass peas, colza. Fruit trees, such as mulberry and apricot, are found at heights of up to 4,000 meters above sea level. Dried fruits of the mulberry and apricot trees are the main diet of the population. In Baltistan in particular we note the cultivation of apricots, growing at heights of more than 2,000 meters above sea level.

18d. Agricultural Tibetan Oases

Agriculture in Tibet is carried on at the uppermost limits known in the world, at certain points reaching 4,500 - 4,600 metres or even higher. Cultivation is concentrated on early maturing wide-leafed hull-less barley. Thanks to the desert climate, just as in the preceding areas, cultivation here is exclusively of the irrigated type, and only spring types are grown. When planted under European climatic conditions, the native barley grains of Tibet are distinguished by an exceptional tendency to germinate on the root.

19. Agricultural Regions of Northwestern Tian-Shan (Foothill and Mountain Regions of Kirghizia and Kazakhstan)

The northern zones of Western Tien-shan, adjacent to Central Asia, are distinguished by a more humid climate and accordingly by lower temperatures.

The climatic data of the foothills and mountain agricultural areas of Kirgizia and Kazakhstan also differ considerably from the areas of Central Asia. In Przheval'sk (on the Issyk-Kul), the rainfall averages 431 mm, in Alma-Ata 577 mm, and in Chimkent 483 mm. In addition, the distribution of rainfall usually varies from that of Central Asia. The maximum rainfall in Przheval'sk and Alma-Ata occurs in the spring and summer months. Only in areas immediately adjacent to Central Asia do we have a distribution of rainfall approximating that of Central Asia, concentrated in the autumn, winter and spring months.

In Table 22 we present typical climatic data for the agricultural areas of Kirgizia and Kazakhstan.

The foothill and mountain areas of Kazakhstan and Kirgizia are characterized by other types of wheats and barleys, constituting a kind of intermediate group between the Siberian and Turkestan forms. Here arose peculiar local club and common wheats, less coarse than those of Central Asia, maturing rapidly and having a lesser requirement for warmth. European steppe winter and spring wheats, oats, and barleys introduced here by immigrants grow successfully.

Of 20,000,000 hectares of the territory of Kirgiz SSR nearly 1,000,000 hectares are today under cultivation. In addition, it must be noted that most of the increase in the sown areas occurred within recent years*.

The main concentrations of agriculture, in conformity with the mountainous relief of the country, are located in geographically separated regions. The great concentration of agriculture is to be found in the northern part of Kirgizia in the Chu River Valley, predominantly an area of irrigated cultivation.

The second largest concentration adjoins Uzbekistan, being located between the Alai and Fergana ranges and extending into the valley and foothills of the

* We point out that this work was prepared by the author for the press in 1940. -
[Russian editor's note.]

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX
Fergana. Here are located typical ecotypes of the Iran-Turkestan Region.

In the lowlands mostly cultivated cereals are grown. In the mountainous areas, cereals are as a rule grown without irrigation.

The third large concentration of sown area surrounds the Issyk-Kul Lake*. The following areas are under grain cultivation in the Kirgiz SSR:

Spring wheat	Approximately	400,000	hectares
Winter wheat	"	20,000	"
Barley	"	140,000	"
Leguminous grains	"	4,000	"



FIGURE 91. Hard wheat - *Triticum durum* Desf. India

The mountainous nature of Kirgizia determines the comparatively short vegetation period. Just as in Kazakhstan, no extensive work was carried out in type selection. Hence, the motley nature of wheat fields, the haphazard nature of the type assortment and the variety of the botanical flora. The type flora has been mainly borrowed from various areas of the European and Asiatic parts of the Soviet Union. In the areas adjoining Central Asia, the influence of the Iran-Turkestan agroecological region has made itself especially strongly felt. In the other areas, there is concentrated an assortment mainly borrowed from the European part of the USSR. A certain influence has been exercised by Western China and China in general, which is particularly manifest in the cultivation of the opium poppy (*Papaver somniferum*) and the Chinese kitchen gardens. The influence of the steppe areas of the European part of the USSR and Western Siberia is seen to a considerable extent in the fields of hard wheat. The preponderance of fields in the foothill and mountain areas is taken up by irrigated wheat, thanks to the abundance of water.

* I.I. Vavilov. Plant breeding in Kirgizia and its prospects, in compendium "Problems of the Kirghiz ASSR." Academy of Sciences of the USSR, 1936.

Table 22

Climatic data for agricultural areas of Northwest Tianshan (Foothill and mountain areas of Kirghizia and Kazakhstan)

Place	Data	Month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Przheval'sk, (Kirg. SSR), 42°31' North lat. Elev. 1,770 m	Precipitation (mm).....	19	12	18	41	62	59	61	44	40	36	21	18	431
	Av. temp. (°C).....	-5.1	-4.7	0.8	7.7	12.1	15.8	17.3	16.9	13.1	6.3	1.0	-3.2	6.5
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-31.1
Naryn, (Kirg. SSR), 41°26' North lat. Elev. 2,015 m	Precipitation (mm).....	12	10	18	29	52	40	38	16	17	14	11	10	267
	Av. temp. (°C).....	-16.6	-14.3	-4.3	6.7	12.1	15.5	17.7	17.2	12.6	4.9	-3.9	-12.7	2.9
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-36.1
	Days over +5° C.....	-	-	-	-	-	-	-	-	-	-	-	-	187
Alma-Ata, 43°16' North lat. Elev. 841 m	Precipitation (mm).....	33	23	53	97	90	60	40	29	27	49	45	31	577
	Av. temp. (°C).....	-8.3	-7.1	0.2	9.9	16.1	20.7	23.0	21.7	15.5	7.5	0.3	-5.2	7.8
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-34.7
	Days over +5° C.....	-	-	-	-	-	-	-	-	-	-	-	-	202
Dzhambul, (Aulie-Ata Kaz. SSR), 42°53' North lat. Elev. 620 m	Precipitation (mm).....	21	22	40	47	37	23	9	6	9	30	32	20	296
	Av. temp. (°C).....	-4.2	-2.5	2.9	11.6	18.2	22.8	24.8	22.4	16.3	9.6	2.8	-1.4	10.3
Chimkent, Kaz. SSR, 42°19' North lat. Elev. 505 m	Precipitation (mm).....	25	51	91	97	32	13	2	0	4	57	55	46	473
	Av. temp. (°C).....	-2.1	-1.0	5.9	12.1	17.6	24.0	26.4	25.1	19.0	12.2	4.8	-0.7	11.9

Of the standard varieties Ukrainka grows successfully here, and competes with local types. Interest is afforded by Novokrimka and Kanred. For the drier areas of adequate water supply *Erythrospermum* 0321 has chances of development. Of the barleys, according to the data of the State Plant Testing Commission, the most successfully developed is the 2-row *Medicum* 026, selected by the Krasnokutsk Station, as well as certain Caucasian barleys, for instance, *Kolkhikum* 041, selected by the Krasnovodopad Experimental Station. Under conditions of assured water supply, *Pobeda* (Victory) and *Zolotoi Dozhd'* (Golden Rain) oats can grow here. As compared to Kazakhstan, Kirgizia as a whole is distinguished by better water conditions of agriculture, less severe winters, and the possibility of more extensive cultivation of winter wheat.

The large Kazakhstan area is characterized mainly by semi-desert and desert areas, climatologically belonging to the Irano-Turkestan agroecological region, being distinguished only by a lower temperature as a result of a more northerly situation.

The total area under cultivation here reaches 6.4 million hectares (1940), tending predominantly to foothill areas. Agriculture is both irrigated and non-irrigated, with a marked tendency towards an increase in irrigated areas.

The local flora of varieties of the foothill and mountainous areas of Western Tienshan, when planted within the boundaries of Kazakhstan and Kirgizia, mainly displays an alien character. Types have been borrowed from the European part of the Soviet Union, Western Siberia, and also partly from Central Asia. Hence, the exceptional motley nature of botanical species. According to calculations made by A.A. Orlov*, soft and hard wheats are here represented by 120 botanical subspecies. The most widespread is soft wheat. Of the spring wheat, the standard types for humid areas are considered to be *Tsezium* O 111, *Milturum* 0321, selected by the West Siberian Station, and hard wheat *Hordeiforme* 010. For dry areas accepted standard types are to be *Grecum* 0283, *Erythrospermum* 0841 and *Erythrospermum* 0341; for hard wheats *Hordeiforme* 0109 and *Hordeiforme* 0432. We also find *Melyanopus* 069, from the Krasnopus Experimental Station. Of winter wheats the standard for Southern Kazakhstan is held to be the *Cooperator*ka.

India and Pakistan

Of the entire large territory of India, nearly 100,000,000 hectares are devoted to agriculture. The main concentrations of sown wheat (Figures 91-92), barley and leguminous seed crops occur in the northwestern part of India. Cultivated flax (Figures 93-94) occupies a large area. A considerable area under oleagenous flax is concentrated in Central and Eastern India.

As a result of the extensive area, the relief of the country, the influence of the Himalayas and the Tar desert and the monsoons, the character of the climate of India is highly varied. The Himalayan barrier shuts off the country from the influence of the deserts of Central Asia. The amount of rainfall increases as we proceed to the east from the Tar Desert, which extends in wedges from the northwest, where in certain localities it exceeds 500 mm.

Agroecologically we may distinguish four basic regions within the borders of India:

20. Southern slopes of western Himalayas, including Kashmir and elevated regions of the Northwest.

* A.A. Orlov. Botanical Geographical Outline of the Wheats of Kazakhstan, *Sel'sko Khozyaistvennaya Nauka v. Kazakhstane* (Agricultural Science in Kazakhstan), No 1, 1934, p 45-52.

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

21. Northwestern arid low-lying areas of India, including Punjab, the North-West frontier province including Peshawar, Sind, and the western part of Rajasthan.

22. Central India.

23. The Baluchistan Mountainous Agricultural Region.

20. Southern Slopes of Western Himalayas, Including Kashmir and Elevated Regions of the Northwest

182 A typical feature of this mountain region is the adequate amount of rainfall, which is concentrated in the middle of the year, and the fact that it is sheltered from the cold, dry, northern winds. Thanks to the high location above sea level of the area of Kashmir, the temperature is comparatively low, fluctuating annually around 10-14° C. The amount of rainfall varies from 500 to 1,200 mm per year. The capital of Kashmir, Srinagar, located among important agricultural areas, is



Map 3. Hindustan and adjoining areas. Areas under cultivation as of 1936 (cultivated area without fallow land, but including gardens and vineyards). Each dot corresponds to 250,000 hectares. Compiled by I. F. Makarov and I. V. Chekan. Edited by Acad. N. I. Vavilov.

situated at a height of 1,500 meters. A negative factor for agriculture is the autumn and spring drought. Here, as in India as a whole, a large part of the rainfall occurs in July and August. In certain years, wheat suffers from leaf rust during the final period of development. Despite the large amount of rainfall, agriculture in Kashmir is exclusively irrigated. The sowing of wheat is carried out predominantly in the autumn. Typical climatic data for this region are presented in Table 23.

A characteristic of the wheat varieties here is the presence of mostly small-spike forms with a spreading bush at the beginning of vegetation, comparatively tall

Table 23
Climatic data for the Indian (mountainous) agroecological region

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Cherat (North-west frontier province), 33°50' North lat. Elev. 1,297 m	Precipitation (mm).....	57	84	91	64	36	17	115	92	47	2	3	28	636
	Av. temp. (°C).....	6.1	14.1	16.8	19.6	26.2	29.3	26.3	25.6	24.2	19.9	14.3	9.0	19.3
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—5.8
	Days over +5°C.....	—	—	—	—	—	—	—	—	—	—	—	—	242
Myuri (North-west frontier province), 33°55' North lat. Elev. 1,943 m	Precipitation (mm).....	95	105	100	92	76	87	318	340	143	47	32	35	1470
	Av. temp. (°C).....	4.7	5.1	10.6	16.2	22.2	22.4	20.8	19.6	18.8	16.3	11.6	7.2	14.6
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—11.1
	Days over +5°C.....	—	—	—	—	—	—	—	—	—	—	—	—	341
Rawalpindi (North-west frontier province), 33°37' North lat. Elev. 199 m	Precipitation (mm).....	64	53	53	52	36	45	209	196	81	13	16	28	846
	Av. temp. (°C).....	9.2	11.1	17.2	23.2	28.4	31.5	30.1	28.7	26.8	21.4	14.6	10.1	21.0
	Abs. min. temp.* (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—4.5

* Frosts do not occur every year.

184 bushiness with violet sprouts, with a small ear, and small, narrow grain. Under Central European conditions the winter resistance of these types is low. The type of the spike is distinctly different from that of the Central Asiatic wheats, particularly the soft, slender awns. In its cultivated flora of leguminous seed crop and flax types, Kashmir stands close to the Kabul area of the Iran-Turkestan agro-ecological region. Flax here is for the most part represented by low, extensively branching shrubbery. Leguminous seed crops are of the small-seed, chiefly dark-colored intermediately maturing type.



FIGURE 92. Soft wheat - Triticum vulgare Vill. Kashmir



FIGURE 93. Flax - Linum usitatissimum - Small seed dwarf; India

21. Northwestern Arid Low-Lying Areas of India, Including Punjab, the North West Frontier Province Together with Peshawar, Sind, and the Western Part of Rajasthan

185 On the whole, the areas of Northwestern India are fairly varied in climate, depending on height above sea level. Low-lying zones are characterized by a dry climate. The amount of rainfall varies from 250-480 mm per year. The average yearly temperature is nearly 20° C. The soils of the region are frequently light, almost neutral, and poor in organic substances. The typical natural vegetation of the region is tropic savannah. Agriculture is exclusively of the irrigated type. The higher areas are characterized by a considerably greater amount of rainfall, varying from 700 to 1,500 mm. The growth of cereals is usually carried out without irrigation and sometimes even suffers from an excess of moisture. However, the types of wheat, barley, flax, and leguminous seed crops of Northwest India, despite the varied nature of the conditions are quite uniform and can readily be united into a single group. Here wheat suffers rather from an insufficiency of cold in winter. With irrigation the area is an exceptionally favorable one for the growth of wheat (when sown in the autumn) and cotton, inasmuch as summer is hot and autumn dry. Typical climatic data are shown in Table 24.

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

Large quantities of wheat, represented almost exclusively by spring forms, are grown here, as well as leguminous seed crops, olives, flax and colza.

Of the leguminous crops, the most widespread is the chick pea, which covers millions of hectares. Characteristic of this territory is the large area devoted to irrigated wheat, the most important concentration of irrigated wheat in the entire world. Wheat and barley are usually sown in autumn, and flax in the dry winter period following the autumn monsoons. The leguminous seed crops are sown in early spring.

The hot summer makes for a short growth period and the speed of maturation specific for the majority of the annual crops of this important ancient breeding-ground of agriculture. Owing to the short day peculiar to India, the Indian types react poorly to the shortened day and have great requirements for warmth, particularly during the period from the time of spike formation to maturation, and for this reason, in the north, despite the exceptionally swift maturation, they do not always ripen.



FIGURE 94. Flax - Linum usitatissimum L., Large seed, India

22. Central India.

This includes the Central Indian plateau of Deccan, the Central Provinces and adjacent south-lying Hyderabad, which resembles the Deccan plateau in cultivation conditions, but differs by possessing a more uniform climate. Administratively speaking, Deccan comprises Central India as well as the eastern part of the State of Bombay. This is a spacious elevated region characterized by dark-colored dense soils - "Regur." The natural vegetation is the tropic savannah. The amount of rain varies from 500 to 1,250 mm, the quantity rising as we proceed

Table 24
Climatic data for the Northwest lowland dry part of India

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Bikaner, (Rajasthan), 28°01' North lat. Elev. 234 m	Precipitation (mm).....	10	5	4	4	21	42	84	80	27	2	2	2	233
	Av. temp. (°C).....	15.1	17.6	24.3	31.3	34.5	34.3	33.4	30.7	30.8	23.0	21.4	16.3	26.5
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—0.3
Sirsa, (Punjab), 29°32' North lat. Elev. 202 m	Precipitation (mm).....	18	19	10	9	16	52	94	92	50	6	0	9	375
	Av. temp. (°C).....	13.0	14.7	22.3	29.1	33.1	34.4	32.3	31.1	30.0	25.5	18.4	13.7	24.8
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—1.2
Peshawar (North- west frontier province), 34°02' North lat. Elev. 338 m	Precipitation (mm).....	39	33	48	45	17	7	42	55	17	5	15	14	337
	Av. temp. (°C).....	9.8	11.9	17.4	23.1	28.9	32.9	32.4	30.9	27.8	21.9	15.1	10.6	21.9
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—4.1
Sialkot, (Punjab), 32°31' North lat. Elev. 253 m	Precipitation (mm).....	49	47	40	32	27	76	261	247	76	12	7	20	394
	Av. temp. (°C).....	11.4	13.3	20.0	26.9	31.5	33.7	30.9	29.6	28.8	24.3	17.4	12.3	23.4
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—2.7
	Days over +5° C.....	—	—	—	—	—	—	—	—	—	—	—	—	365

from north to south. The basic crops are cotton, sorghum, and flax. The coastal part of India is used mainly for the cultivation of rice (State of Madras). Ecologically speaking, we also group here the central part of Northern India located along the middle reaches of the River Ganges, taking in the United Provinces and Behar, which are characterized by a variety of cultures. Large quantities of wheat, flax, and chick pea are grown here. In contrast to the south, the soils are alluvial. The amount of rainfall increases as we go from west to east. The average annual rainfall is approximately 750 mm, and in the eastern parts, amounts to 1,300 mm. A small quantity of rainfall is characteristic of Behar (Table 25).

Ecologically speaking, within the limits of India we differentiate Bengal, located on the lower reaches of the Ganges, with a tropical, littoral, extremely humid climate. For the cultivation of the crops we are considering it has a comparatively small value. Its principal crops are rice, (*Oryza sativa* L.), jute (*Corchorus olitorius* L., *C. capsularis* L.) and cotton. The southern part of the Hindustan peninsula is mainly devoted to tropical plants, such as the coffee bush (*Coffea arabica*), spice plants, cardamom (*Elettaria cardamomum* Salib.), ginger (*Zingiber officinale* Rosc.), cinnamon (*Cinnamomum zeylanicum*) mango (*Mangifera indica* L.) and coconut palm (*Cocos nicifera* L.) which is even more widespread on the island of Ceylon. Of the cereals the chief crops are rice "ragi" (*Eleusina corucana* Gärten.), pearl millet (*Pennisetum glaucum* R. Br.). The monsoon weather and the hot summer of the larger part of India occasions the short vegetation period and swiftness of maturation specific for the annual crops of India, as well as the developmental stages. The light stage is determined by the shortened light day. The fact that rainfall occurs during the summer creates the necessity of speedy maturation to eliminate fungal infection. Accordingly, the wheats of India are distinguished by comparative resistance to rust damage. Typical features of the Indian varieties of wheat, barley, leguminous seed crops, and flax are their small size, small



Map 4. Indo-China and Indonesia. Agricultural areas as of 1936. (Cultivated non-fallow areas, including gardens and vineyards). Each dot corresponds to 250,000 hectares. Compiled by I. F. Makarov and I. V. Chekan. Edited by Academician N. I. Vavilov.

Table 25

Climatic data of Central India

Place	Data	Month												Ave. temp.
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Indhor (Central Province), 22°44' North lat. Elev. 556 m	{ Precipitation (mm).....	6	6	1	4	12	161	248	197	115	28	6	4	788
	{ Av. temp. (°C).....	17.8	19.7	24.6	29.7	31.4	29.7	25.3	24.5	24.9	24.1	20.2	17.7	24.0
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—2.8
Agra (United Provinces), 27°10' North lat. Elev. 169 m	{ Precipitation (mm).....	14	8	6	4	16	72	250	184	114	10	2	7	687
	{ Av. temp. (°C).....	15.6	18.2	24.8	31.2	34.4	34.1	30.0	29.0	29.0	26.3	20.4	16.2	25.8
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—1.1
Nagpur, 21°09' North lat. Elev. 313 m	{ Precipitation (mm).....	15	11	14	12	17	214	343	249	206	54	13	11	1159
	{ Av. temp. (°C).....	21.4	23.5	28.0	32.6	34.7	30.3	26.9	26.3	26.9	25.8	22.3	19.5	26.4
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—
Hyderabad, 17°20' North lat. Elev. 515 m	{ Precipitation (mm).....	2	2	14	17	20	112	150	167	175	84	32	10	785
	{ Av. temp. (°C).....	21.3	25.1	28.4	31.1	32.3	28.1	25.1	25.1	25.2	24.9	22.4	20.6	25.8
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—

Note: Under the conditions prevailing at Nagpur and Hyderabad, frosts are only occasional.

- 189 grain, a certain coarseness of their ears, their resistance to drought weather, their later developmental phase and great requirements for warmth, particularly in the period between the formation of the ear and maturation. The wheat of India is characterized by poor dissemination qualities.

Among the wheats and barleys, there is a sharp predominance of spring forms. The Indian wheat type is essentially a spring one. Many Indian varieties possess a high quality grain with a hyaline appearance.

- The flaxes are distinguished by a large yield of oil. The flax varieties of the northwestern depression differ from the southern forms of the Deccan: the former have small seeds, with a shallow root system, which results from the rich moisture of the alluvial soil: the latter have seeds of intermediate and large size with a well-developed, deeply penetrating root system. These flaxes are grown on the heavy soils of Central Hindustan. Together with negative qualities, such as the small size of the grains and the comparatively low productivity, cereals and leguminous crops are distinguished by a series of positive properties. Indian wheat participated in the amelioration of many types in Canada and Australia and the latter borrowed from them their speedy maturation, high quality of the grain and resistance to fungal diseases. Indian wheats participated in the formation of the Novinka variety. As we shall see later, the wheats and barleys of China in all probability are of Indian origin.
- 190

In Central India, partially in the Punjab, Percival discovered an endemic species of circular grain wheat T. sphaerococcum, distinguished by low height, exceptional elasticity, absolutely non-recumbent straw, short conical leaves, compact ears, and spherical grain. In general, the types of Indian cereals and leguminous seed crops are also distinguished by smallness of grain. Lentils are represented by dark-colored and even black-seed forms, with beans showing a tendency to split.

23. The Baluchistan mountainous agricultural region.

The mountain areas of Baluchistan, where concentrations of irrigated cultivation of wheat, barley and other plants occur, in general resemble the arid zones of Northwestern India in climate.

Rainfall occurs principally during winter and spring. The summer is burning hot and dry.

Typical climatic data for this agroecological region are presented in Table 26.

The study of the large quantity of samples which we obtained from Baluchistan enabled us to elucidate their peculiarities. In many aspects, they are reminiscent of Indian wheats in their low stalk, and their small ear and grain, but at the same time, among many samples, we observed, as it were, forms intermediate to those of the Iran-Turkestan group of wheats, showing this in coarser beard, difficulty of threshing and coarseness of scales. It is possible to follow the gradation of forms from those similar to Iran-Turkestan wheats to typical Indian wheats indistinguishable from the local varieties of Northwestern and Central India. The variety of forms of Baluchistan wheats also shows itself in respect to brown rust. Together with highly vulnerable forms resembling Iran-Turkestan wheat, a considerable number of local types with pronounced immunity to brown rust has been discovered here. In brief, Baluchistan wheats, as it were, constitute a transition from Iran-Turkestan wheat to the typical Indian wheat, and for this reason may be

Table 26
Climatic data for the Baluchistan mountain agroecological region

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Quetta, Baluchistan 30°12' North lat. Elev. 1,677 m	Precipitation (mm)	48	54	46	24	11	4	12	13	2	2	10	25	251
	{ Av. temp. (°C)	4.2	5.7	11.4	16.1	20.0	23.4	25.7	24.1	19.5	13.6	8.9	6.7	14.8
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—19.4
	{ Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	385
Chaman, Baluchistan 30°55' North lat. Elev. 1,314 m	Precipitation (mm)	39	52	36	16	2	2	2	0	0	1	15	29	193
	{ Av. temp. (°C)	6.3	8.2	13.3	21.3	26.8	29.5	31.1	28.7	24.8	18.2	13.7	8.8	19.2
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—17.7
	{ Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	965

placed in a special group. They differ from Indian wheats, thanks to the peculiarities of the dry climate, a high degree of resistance to drought. Baluchistan barley has been described by G. and A. Howard* in a special monograph and apparently also occupies an intermediate position between typical Central Asiatic coarse-eared forms and the fine-awned, small-kernel, small-spike forms of India.

Arabia

24. Mountain Arabian Agroecological Region (Yemen)

Agriculture in mountainous South-west Arabia (Yemen), the so-called "Happy Arabia (Arabia Felix)", is principally concentrated in the mountain areas (Jebel), starting at a height of 1,600 meters. The most important ancient agricultural area is located near the capital of Yemen — the town of San'a, situated at a height of 2,400 meters (the sown areas have been tentatively estimated at 400,000 hectares). It is separated from the Red Sea by a semi-desert coastal strip (Tihama), with rare agricultural oases.

The average amount of rainfall here is about 700 mm (San'a). This decreases at lower altitudes. Just as in mountainous Ethiopia, the rainfall occurs in the period from July to September inclusive. In contrast to Ethiopia, the climate of Arabia is dry. In general, the Yemen constitutes a small ancient focus of agriculture adjacent to the deserts. In its climate it approaches somewhat the mountainous parts of Ethiopia, but differs by a more marked dry period. Sowing, as in Ethiopia, is carried out at the beginning of the rainy period in the month of July, and the harvest takes place in October and November. Just as in Ethiopia, a second sowing sometimes occurs in February.

The temperature is comparatively even. The hot climate made possible the evolution of original "ephemeral" plants which complete their growth exceedingly quickly. The characteristic feature of the mountainous part of Arabia, as regards the varieties of the flora, is the presence of local types of the most varied cultures and the remarkable rapidity of maturation, which constitutes a world record for speed of ripening. Exceptionally early types of hard wheat, two-grained wheats, barley, peas (Figure 95), lentils, grass peas, and Trigonella have been discovered here.

The Yemenite blue lucerne is characterized by speedy development from the spring. It terminates its growth very rapidly — in $1\frac{1}{2}$ - 2 months, and as it were, approaches annual plants. The typical description of the mountainous Arabian crop is the following: low in height, small foliage, small ear, and usually relative susceptibility to European fungal diseases.

Ethiopia and Eritrea

25. Ethiopia Agroecological Region (Including High-Mountain Regions of Ethiopia and Eritrea)

Agriculture in Ethiopia is concentrated principally in the high mountain areas, the so-called "Dega" and "Voina" areas, located at a height of 1,600 - 3,000 meters above sea level. The areas of the "Voina", characterized by a subtropical climate, are situated at a height of 1,600 - 2,000 meters; the Dega is located at a height of from 2,000 meters up to the altitude limits for cultivation. The highest fields which we discovered here in 1927 were at 3,100 meters. according to the data in the literature, fields occur at 3,700 meters.

* G. Howard and A. Howard, The Agricultural Development of Baluchistan. Agric. Res. Inst. Bull., 119, Pusa-Calcutta, 1921, pp 1-27.



Ethiopia. Segha-Vadem. Tributary of the Blue Nile



Blue Nile (near Abba1)



Central Ethiopia, near Fich, inhabitants of villages



Eastern Ethiopia, Harrar. Thickets of Acacia and wood-like spurge (Euphorbia abyssinica)

The main areas sown with cereal (Figures 96-108), leguminous seed crops (Figures 109, 110a, and 111) and flax (Figure 110) are situated in the "Dega". On the average the annual rainfall is approximately 1,000 mm. Somewhat less rainfall occurs in the "Voïna", but as a whole the agricultural areas of Ethiopia are characterized by approximately 1,000 mm of rainfall, which occur in two periods, the majority in July-September (the "Great Krint" rains), after which a



FIGURE 95. Abyssinian peas—Pisum abyssinicum Braun. Yemen



FIGURE 96. English wheat—triticum turgidum L., ssp. abyssinicum Vav., rare form with flat-ear scales. Ethiopia



FIGURE 97. English wheat—triticum turgidum L., ssp. abyssinicum Vav., Ethiopia, area of Addis Ababa

dry period sets in lasting to February-March, when the rains again fall in considerable quantities ("Small Krint"). Among the peculiarities of the climatic conditions we must also include the short tropical day peculiar to Ethiopia.

We present typical climatic data in Tables 27 and 28.

Certain areas of Ethiopia, for instance Harrar, are characterized by an annual and daily uniformity of temperatures.

At certain points of the "Voina" the temperature remains at the same level, as in a thermostat; the difference between the extremes of temperatures does not exceed 3-5° C, including yearly, daily and nightly fluctuations. In general the climate of the agricultural zone of Ethiopia approaches a subtropical climate even at high elevations of 2,300-2,500 meters. In the vicinity of Addis Ababa (2,440 meters above sea level) and Ankobor, there is widespread cultivation of the eucalyptus (Eucalyptus globulus Labill. and other species) imported here from Australia. The temperature falls below 0°C at a height of 2,700 meters. Agriculture is exclusively non-irrigated. The sowing of cereals, leguminous seed crops and flax takes place mainly at the beginning of the large downpours in July. More rarely it occurs in the periods of the "small rains"

The large assortment of types which our expedition in Ethiopia collected in 1927 and which were tested by being sown in different areas of the USSR have shown that Ethiopia is characterized by spring forms exclusively, both of wheats and barley. Rye does not grow at all here even as a field weed. Oats are represented only by wild species (Avena abyssinica Hochst. and Avena Vaviloviana Malz.).

196 The species and varieties of cultivated plants (wheat, barley, peas, lentils, grass peas, beans and flax) are characterized by comparatively swift maturation, which is connected with the arrival of drought in October. The varieties react as a rule very weakly to vernalization, or do not react at all in the sense of a shortening of the growth period. The light stage is intermediate or long, despite the location of Ethiopia near the equator. Flax, lentils, grass peas, chick peas and beans, are of comparatively low height and have small leaves. In contrast barley and peas are tall. Very characteristic of Ethiopia is the presence of both mesophyte and xerophyte forms, connected with the fact that sowing occurs at various periods. The forms sown before the beginning of the period of the great rains are more hydrophylic, while the forms sown after some delay or around the period of the "small Krint" suffer from drought, and accordingly more xerophytic types evolve. Within certain limits, a considerable amplitude in the variety of the ecological types varying from mesophyte to xerophyte is observed. We must note in the flora of crops in Ethiopia, the presence of alien elements introduced from the mountainous parts of Arabia (the Yemen), distinguished by a greater degree of xerophily, smaller grains, low height, and swiftness of maturation. Among these apparently are Ethiopian lentils and a special species of peas (Pisum abyssinicum Br.), characterized by smallness of grains, low height and rapid maturation. This species of peas differs markedly from the ordinary Ethiopian large-seed pea, whose appearance is similar to that of European varieties. In contrast to these typical foreign xerophytes and mesophytes, which evolved under dry period conditions, other Ethiopian crops, such as true Ethiopian peas, Ethiopian barleys, mustard and cabbage (Brassica carinata A. Br.), are characterized by tall height, considerable foliage and moderate humidity requirements. These are mesophytes with a tendency to hydrophily.

It is highly important to note that Ethiopian types of barley, pea, grass peas, mustard, cabbage and to some extent wheat grow normally under the conditions of the European part of the Soviet Union, even in the far north, beyond the Arctic Circle, where they are somewhat inferior in quality to the best local northern Russian and Scandinavian types. A number of hard wheats of Ethiopia has ripened in the course of a number of years beyond the Arctic Circle (Khibina), and given a comparatively good production of grain. The typical peas and barleys of Ethiopia are characterized by modest requirements for warmth during the period of maturation.

As proved by means of comparative research, the mountainous parts of Ethiopia constitute a remarkable breeding ground for endemic species, subspecies and

Table 27

Climatic data for certain points of the Ethiopian agroecological region

Place	Data	Month												Remarks
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Addis Ababa 9°02' North lat. Elev. 2,440 m	Precipitation (mm) ...	9	48	105	85	78	146	305	292	161	14	13	3	Average for 4 years
	Av. temp. (°C)	15.2	15.1	16.4	16.4	17.9	15.2	13.7	14.0	14.3	15.7	15.3	14.3	
	Abs. min. temp. (°C)..	—	—	—	—	—	—	—	—	—	—	—	—	
Harrar 9°42' North lat. Elev. 1,856 m	Precipitation (mm) ...	21	8	61	102	212	82	131	138	91	15	17	17	Average for 3 years
	Av. temp. (°C)	17.7	18.5	19.8	19.6	18.8	13.4	17.5	17.4	17.6	17.3	17.3	16.7	
	Abs. min. temp. (°C)..	—	—	—	—	—	—	—	—	—	—	—	—	

Av. temp.

Table 28

Climatic data for certain points of the Ethiopian agroecological region

Place	Temp. of warmest month	Temp. of coldest month	Av. abs. annual temp. min. (°C)	Annual precipitation
Gondar, Ethiopia. 12°36' North lat. Elev. 1,904m	+22.7	15.8	—	1011
Addi-Ugri, Eritrea 14°53' North lat. Elev.2, 022m	21.5	17.3	7.2	639
Keren, Eritrea 15°47' North lat. Elev. 1,460m.	25.6	18.3	—	580

197 varieties of cereals, leguminous crops and other plants. They are characterized by endemic cultivated plants, such as teff, (*Eragrostis abyssinica* Schrad.) and Ethiopian banana (*Musa enesete* Gmel.), introduced into cultivation from wild flora.

Although no wild species of wheat, barley and peas have been discovered here nevertheless the individuality of the species and varieties of wheat, barley, peas and flax shows the isolation of this particular group and their remoteness in time from the corresponding Anterior Asian species and varieties. Wheats in Ethiopia are represented mainly by the 28-chromosome species. Soft wheat, although met with here in the form of admixtures, nevertheless adapted itself so well to the basic Ethiopian species that it constitutes a remarkable example of assimilation as a result of the prolonged action of selection. Among the hard wheats, particular interest from the selection point of view attaches to beardless forms. We note the unique violet grain wheats not encountered anywhere else in the world. We classified the barleys of Ethiopia into a special subspecies — *Hordeum sativum* ssp. *aethiopicum* Vav. — because of a complex of characteristics: the narrow leaf, the

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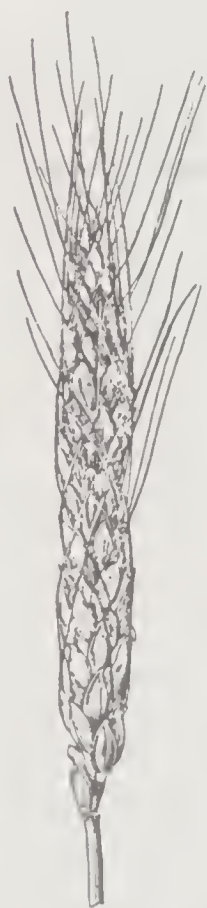


FIGURE 98. English wheat—*Triticum turgidum* L., ssp. *abyssinicum* Vav., loose-ear form, Ethiopia, area of Addis Ababa



FIGURE 99. English wheat—*Triticum turgidum* L., ssp. *abyssinicum* Vav., Ethiopia, area of Addis Ababa



FIGURE 100. English wheat—*Triticum turgidum* L., ssp. *abyssinicum* Vav., Ethiopia, area of Gondar

large grain, resistance to loose and stinking smut. They are also distinguished by comparatively minor susceptibility to brown and yellow rust. A highly valuable property is the fact that they do not lie recumbent.

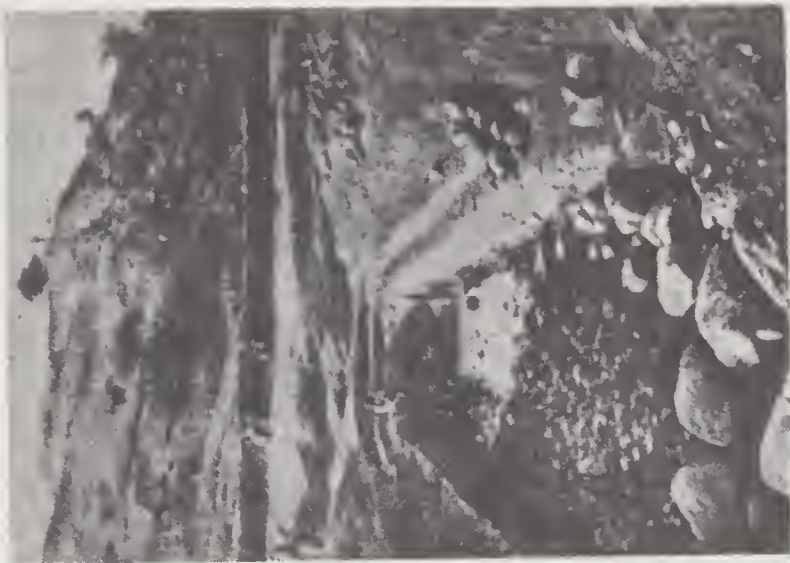
As participants in cross-breeding and amelioration of European types, they are undoubtedly of considerable interest. In Ethiopia, we meet both six-row and two-row varieties, dense-eared, crumbly-eared, hulled and hull-less types. In variety of types, cultivated barleys of Ethiopia may be placed in the foremost rank.



Ethiopia. Harrar. Galas peasants



Ethiopia. Woman peasant near Addis Ababa



Ethiopia. Water - collecting installations



Eritrea. Baobab

- 201 As shown by cross-breeding experiments, certain forms of Eastern Asiatic and Eurasian cultured barleys when crossed with Ethiopian display a considerable degree of sterility (through seed infertility), by this trait alone revealing a certain genetic isolation.



FIGURE 101. Common wheat—Triticum vulgare Vill.
Ethiopia

The peas of Ethiopia represent a rich find as feeding plants for northern areas and some of them may be used in a ready form without any particular selection.

A peculiarity of Ethiopian peas is their large seeds and high content of protein-cystine.

The flaxes of Ethiopia are represented by two ecotypes. The Harrar forms



FIGURE 102. Barley—Hordeum
vulgare L., var., pallidum Sér.,
Ethiopia



FIGURE 103. Barley—Hordeum
vulgare L., var. nigripallidum Reg.,
Ethiopia



FIGURE 104. Barley—Hordeum distichon L., var abyssinicum Sér., Ethiopia



FIGURE 105. Barley—Hordeum distichon L., var. deficiens Steud., Ethiopia



FIGURE 106. Barley - Hordeum distichon L. var. zeocrithideficiens Vav. Ethiopia



FIGURE 107. Barley—Hordeum vulgare L.,
var. eurylepis Körn, Ethiopia

- 206 which evolved under more arid conditions are distinguished by swift maturation, smaller degree of branching, and greater resistance to drought. In more humid areas of Addis Ababa, Fich, Ankober and Gondar, there later evolved branching flaxes. In general, the flaxes of Ethiopia are characterized by the smallness of their seed and their moderate oiliness. In Ethiopia they are used mainly for the preparation of fodder meals, obtained by milling the seeds after drying. Grass peas, chick



FIGURE 108. Abyssinian oats — Avena abyssinica Hochst
Weed in barley, Ethiopia, Harrar area

- 207 pea and beans are distinguished by the smallness of their seed, which resembles the varieties of India and Afghanistan. Genetically speaking, as shown by experiments carried out in the crossing of Ethiopian lentils with European and Asiatic forms, they are somewhat isolated, and reveal sterility.

The Mediterranean Countries

26. True Mediterranean Agroecological Region

The true Mediterranean agroecological region takes in chiefly the low-lying foothill areas located along the shores of the Mediterranean Sea, characterized by a typical mild subtropical climate. This includes the areas of Southern Spain (Andalusia) and Valencia, Southern Portugal, the southern part of the Apennine Peninsula (Calabria, Appulia), the southern areas of Greece, the western and southern areas of Asia Minor, and the coastal areas of Algeria, Tunisia and Morocco. It includes the large number of islands of the Mediterranean, such as Sicily, Sardinia, Malta, Rhodes, the Aegean Islands, and the low-lying areas of Crete and Cyprus.



FIGURE 109 Sow pea - Pisum sativum L.
Ethiopia

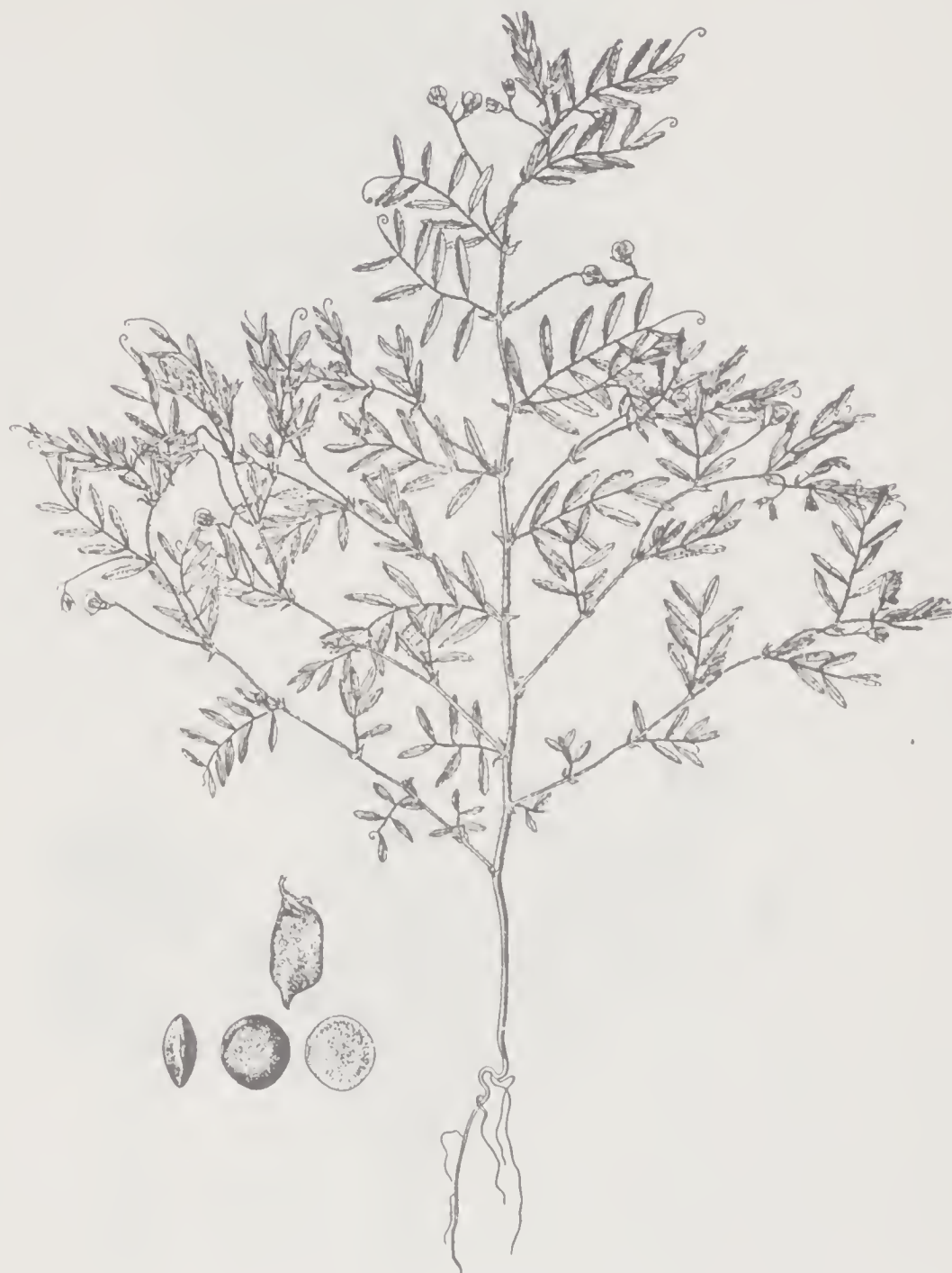


FIGURE 110a. Lentils Lens esculenta L.,
var. abyssinica (Hochst) Al., Ethiopia



FIGURE 110. Flax - Linum usitatissimum L.,
Earley, Ethiopia



FIGURE 111. Chick peas - Cicer arietinum L., Ethiopia

Table 29

Climatic data for the true Mediterranean agroecological region

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Granada, Spain 37°11' North lat. Elev. 760 m	{ Precipitation (mm)	59	40	61	62	48	21	2	5	47	52	49	55	501
	{ Av. temp. (°C)	6.8	8.4	10.4	13.0	16.6	21.4	25.2	24.7	20.1	14.5	10.2	6.4	14.7
Malaga, Spain 36°43' North lat. Elev. 760 m	{ Precipitation (mm)	80	56	78	61	23	9	2	4	33	76	90	87	599
	{ Av. temp. (°C)	12.3	13.3	14.7	16.9	19.3	23.0	25.8	26.1	23.6	19.7	15.9	13.1	18.6
Rome, Italy 41°54' North lat. Elev. 50 m	{ Precipitation (mm)	79	62	63	65	56	39	17	27	73	115	111	21	733
	{ Av. temp. (°C)	6.7	8.1	10.4	13.3	17.8	21.8	24.3	24.3	21.2	16.5	11.3	7.7	15.4
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—8.8
Naples, Italy 40°52' North lat. Elev. 150 m	{ Precipitation (mm)	89	71	73	66	50	32	15	28	71	111	115	110	831
	{ Av. temp. (°C)	8.2	9.1	10.8	13.6	17.6	21.3	24.2	23.9	21.0	17.3	12.6	9.3	15.8
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—4.5
Palermo, Sicily 38°06' North lat. Elev. 70 m	{ Precipitation (mm)	99	34	70	66	34	16	8	14	37	98	99	115	690
	{ Av. temp. (°C)	10.3	11.0	12.6	14.9	18.1	21.7	24.6	24.9	22.9	19.5	15.1	11.9	17.3
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—1.9
Larisa, Thessaly, Greece 39°27' North lat. Elev. 75 m	{ Precipitation (mm)	45	17	36	38	45	38	34	23	26	47	67	48	494
	{ Av. temp. (°C)	5.1	7.4	10.7	14.8	20.2	24.8	27.7	27.4	22.7	17.4	11.1	7.7	16.4
Athens, Greece 37°58' North lat. Elev. 107 m	{ Precipitation (mm)	62	37	34	21	20	17	7	9	14	44	73	62	390
	{ Av. temp. (°C)	8.6	9.4	11.9	15.3	20.2	24.4	27.3	21.9	23.5	12.4	14.1	10.5	16.6

(Contd.)

Table 29 (continued)

Place	Date	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Haifa, Palestine 32°48' North lat.	Precipitation (mm).....	173	100	61	28	8	1	0	0	2	24	102	180	679
	Av. temp. (°C)	12.2	13.5	15.8	18.8	21.4	24.4	26.6	27.2	26.6	23.9	19.1	14.6	20.3
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	-1.6
Smyrna, Turkey 38°25' North lat. Elev. 10 m	Precipitation (mm).....	164	134	87	68	42	8	4	2	63	149	52	97	875
	Av. temp. (°C)	7.6	8.8	11.5	15.1	20.3	24.1	26.8	26.2	22.5	18.7	13.3	9.4	17.0
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	-3.1
Adana, Tarsus Elev. 15 m	Precipitation (mm).....	99	81	74	41	57	13	7	4	14	37	79	104	610
	Av. temp. (°C)	10.0	12.6	14.6	19.3	23.3	25.6	28.8	27.9	26.5	21.8	15.0	12.4	19.9
Tripoli, 37°31' North lat. Elev. 18 m	Precipitation (mm).....	82	48	24	12	7	1	0	1	10	39	74	100	398
	Av. Temp. (°C)	12.3	13.4	15.7	18.2	20.4	23.5	26.2	26.7	25.7	23.2	18.5	14.1	19.9
Algiers, 36°48' North lat., Elev. 22 m	Precipitation (mm).....	107	90	89	59	33	15	2	7	29	~0	117	137	765
	Av. temp. (°C)	11.9	13.0	14.2	16.1	18.8	21.9	25.0	25.3	23.8	20.3	16.9	13.1	18.3
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	-2
Tunis, 36°47' North lat. Elev. 43 m	Precipitation (mm).....	56	50	60	47	23	16	8	10	22	40	59	64	455
	Av. temp. (°C)	9.3	11.0	12.4	15.3	18.7	23.5	26.3	26.6	24.4	19.9	15.2	11.6	17.9
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	2.0
Casablanca, Morocco 33°37' North lat. Elev. 17 m	Precipitation (mm).....	40	55	74	32	33	4	0	0	10	30	76	55	423
	Av. temp. (°C)	11.9	12.7	14.2	16.4	18.1	20.0	21.7	22.9	21.4	19.0	15.7	13.4	17.3
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	3.9

209 As a whole this is a large ancient region where the agricultures of the ancient world began their development, and is characterized by a warm subtropical climate, mild winters, very dry summers, and comparatively humid spring, autumn and winter. Here sowing is as a rule carried out in autumn. The climatic cycles of the Mediterranean region differ sharply from the European in that the majority of the rainfall here occurs in winter and spring, while the summer period is extremely dry, which does not permit sowing at this time without irrigation. This is also the reason for the fact that sowing as a rule is confined to autumn (Tables 29 and 30).

As may be seen from the climatic data presented, the amount of rainfall, although varying considerably at different points, occurs chiefly in autumn, winter and spring, with a very pronounced dry period in the middle of summer. Because of this distribution of rainfall it is possible to obtain only one harvest, despite the abundant warmth during the year. After harvest, cultivation is almost impossible in many areas of the Mediterranean.

212 The favorable conditions and the mild climate of the Mediterranean region permit the development of cultivated types of a high productivity. Varieties of wheat (Figures 112-116), barley, leguminous seed crops (Figures 117-121), and flax (Figures 122-125), are distinguished by their large seeds, large ears, great height, excellent grain quality, breadth of leaves and bushiness. The leguminous seed crops and flaxes stand out by virtue of their large flowers. This is, as it were, a region of giant forms from the point of view of the dimensions of seeds and fruits. In 1926, during the expedition to Algeria, as already noted, we found in an Arab village varieties of the common onion with bulbs of up to 2 kilograms in weight. Apparently the development of large seeds was encouraged not only by artificial selection but also natural selection, since the distribution of rainfall principally in the spring and autumn requires an accelerated development, which was favored by the enlargement of the seeds. Ancient agriculture was concentrated in the countries of the Mediterranean, and their beginnings may be traced back to the fourth millennium before our era at the very least. They favored the selection of the most valuable varieties, with a large yield and high quality. The ancient local types of the Mediterranean area stand out globally by their extremely valuable properties. On the whole, both species and varieties of wheat, barley, oats, flax, and leguminous seed crops of the Mediterranean region are characterized by extensive immunity to the most widely spread fungal diseases and also to Swedish- and Hessian flies. It is a region, so to speak, of an overwhelming concentration of multiple immunity. Thus, for instance, out of the entire globe, it is precisely the Mediterranean region which is distinguished by the occurrence of a great number of forms of barley resistant to brown and yellow rust. Mediterranean oats belonging to the species A. byzantina are distinguished by resistance to loose smut and crown rust. The large-seed flaxes of the Mediterranean are characterized by resistance to rust (Melampsora lini Ehrenb. Lev.), polysporal browning (Polyspora lini Laff. et Peth) and colletotrichum (Colletotrichum linicola Peth. et Laff.). Hard two-grained wheats and even to a considerable extent local soft wheat are distinguished by a resistance to yellow and brown rust and stinking and loose smut.

As far as the group of crops considered is concerned, the true Mediterranean agroecological region ranks first in the world for high quality grain and valuable biological and physiological properties.

27. Mountain Regions of North Africa

(Atlas Mountain, Kabylia, Rif Mountains in Morocco)

We must differentiate from the true Mediterranean Region the mountain areas of the Atlas and Kabylia and the mountain areas of Morocco contiguous to it



Egypt. Threshing grain in the desert



Egypt. Transportation of wheat on camels in Giza



Village in Lower Egypt



Egypt. Ruins of Karnek. Ancient pictures



FIGURE 112. English wheat *Triticum turgidum* L., Mediterranean form



FIGURE 113. Hard wheat—*Triticum durum* Desf. Egypt

216 on the south, where the original areas of the ancient cultivation are concentrated. We may judge the climate of these mountain areas by that of Tlemcin, Constantine, Batna and Marrakesh. Unfortunately, we have no data at our disposal for the particularly interesting agricultural areas located on the slopes of the Atlas mountains and the hinterland area of Kabylia. In general, the amount of rainfall on the northern slopes of the mountains increases as the mountains rise higher. The southern slopes are under the influence of the Sahara Desert, and accordingly are characterized by a reduced amount of rainfall. Here only irrigated agriculture is possible. A desert climate is also characteristic of the large Morocco-Marrakesh Oasis, which has an average annual rainfall totalling 237 mm (average over six years) (Tables 31 and 32).

Field crops are represented here by wheat, barley and leguminous seeds. Durum wheat grows in the high mountain areas of Morocco at up to 2,000 meters above sea level, but in this case obvious changes are observed, leading to the development of an original variety of durum wheat characterized by a tendency of the grain to shatter (Atlas Afro-ecological group of hard wheats). The flora of varieties of cultivated plants in the mountain areas of North Africa differs considerably from that of the low-lying foothill areas of the true Mediterranean region. For the first time in our many voyages in the Atlas in 1926, we met a markedly pronounced shattering in the period of maturation of durum wheats. This feature proved to be

Table 30
Climatic data for the true Mediterranean agroecological region

Place	Temp. of warmest month (°C)	Temp. of coldest month (°C)	Av. abs. annual temp. min. (°C)	Annual Precipitation (mm)	Abs. min. temp. (°C)
Lagos, Portugal 37°06' North lat. Elev. 760 m	24.9	11.0	1.3	4955	—
Catania 37°30' North lat. Elev. 26 m	26.4	11.4	—	—	−0.5

Table 31
Climatic data of mountain area of North Africa

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Biskra, Sahara 24°51' North lat. Elev. 125 m	Precipitation (mm)	12	19	20	31	15	10	4	8	15	20	11	16	176
	Av. temp. (°C)	10.6	12.7	15.3	19.4	23.7	28.8	31.9	31.2	27.5	21.0	15.0	11.2	20.7
	Abs. min. temp. (°C) . . .	—	—	—	—	—	—	—	—	—	—	—	—	−1.4
Marakesh, Morocco 31°31' North lat.	Precipitation (mm)	31	31	36	27	19	7	5	0	7	12	37	22	2.7
	Av. temp. (°C)	10.9	12.6	15.1	19.3	20.8	25.1	27.8	29.6	24.4	21.0	16.9	12.3	19.6
	Abs. min. temp. (°C) . . .	—	—	—	—	—	—	—	—	—	—	—	—	−2.2
Oran, Algeria 35°42' North lat. Elev. 60 m	Precipitation (mm)	94	73	72	44	44	7	1	2	17	47	82	93	576
	Av. temp. (°C)	11.0	11.8	13.6	16.0	18.8	21.6	24.2	24.8	22.7	18.8	15.1	11.7	17.5
	Abs. min. temp. (°C) . . .	—	—	—	—	—	—	—	—	—	—	—	—	−2.2

Table 32

Climatic data for mountain areas of North Africa (Atlas mountains, Kabilia, Riff mountains of Morocco)

Place	Temp. of warmest month (°C)	Temp. of coldest month (°C)	Annual Precipitation (mm)	Abs. min. temp. (°C)
Constantine, (Algeria) 36°24' North lat.	26.3	6.2	561	-10.2
Ain Dragam 36°48' N. lat.	23.5	6.1	—	0
Tlemsen, (Algeria) 34°53' North lat. Elev. 825 m	24.7	8.5	652	-4.0
Les Chotts 38°48' North lat. Elev. 750 m	26.3	7.0	196	-8.8
Batna, (Algeria) 35°32' North lat. Elev. 1,050m	22.6	4.0	425	-14.0
In Salah (Algeria) 27°17' North lat. Elev. 300 m	36.5	12.2	—	-4.0

hereditary. Leguminous seed crops in the mountain areas, in contrast to the large seed forms of the coastal strip, are represented by small seed, quite often dark-colored forms resembling the leguminous seed-crops of Southwestern Asia. Among the residual forms in the mountain areas have been conserved wild beans (*Faba pliniana* (Trabut) Murat), genetically connected with the small-seed, dark-colored bean of Afghanistan, in the Pamir areas. Grass peas, peas and lentils of the mountain areas, in contrast to the large-seed forms, are overwhelmingly small-seeded. Agriculture here is usually non-irrigated, but in the dry mountain areas on the southern slopes, in the Marrakesh oasis at the foot of the Atlas, crops are irrigated. Exactly as in the Mediterranean region, sowing, thanks to the comparatively mild climate, is done in the autumn or early spring. The summer is dry.

28. Mountain Regions of Cyprus and Crete

Crete and Cyprus played an important cultural role in the remote past. Crete as is known, was the focal center of the Minoan culture. In the past and partly in the present, wild and cultivated plants have been of great importance on both



FIGURE 114. Durum wheat—*Triticum durum* Desf., Algeria



FIGURE 115. Polish wheat—*Triticum polonicum* L., Morocco

of these islands, including the carob tree (*Ceratonia siliqua* L.), olive tree (*Olea europaea* L.), and grapes. Important areas are also devoted to irrigated crops. The low-lying coastal zone of these islands is characterized by a typical Mediterranean climate and forms part of the true Mediterranean region. As against this,



FIGURE 116. Soft wheat—Triticum vulgare
Vill, Alpine type, Italy



FIGURE 117. Sown peas—Pisum
sativum L., Egypt



FIGURE 119. Variability of height of branches, stem and size of leaves in relation to evolution of species Vicia faba, L.



FIGURE 120. Mediterranean sub-species of beans - *Vicia faba* L. ssp. *maxima* f. *macrosperma* (Alef). Murat. Island of Cyprus. Beans (natural size) seed (X2)



FIGURE 121. Plate-like lentil - *Lens esculenta* Moench. ssp. *macrosperma* (Baumg). Bar. var. *nummularia* Al. Italy. Plant, bean (X2), seeds (X4)

222 areas of considerable elevation above sea level are characterized by a harsher climate, faster maturing, larger seeds, and lower forms. Climatic data for the mountain parts of Cyprus unfortunately do not exist. We may judge of the climatic conditions of the low-lying areas from the data for the capital of Cyprus, Nicosia (Table 33).

In the mountain regions of the island of Cyprus, we find large amounts of a peculiar low-height, small-grain, rapidly maturing hard wheat, distinguished by the absence of a ligule. Nowhere in other areas of the globe did we succeed in discovering such non-ligulated hard wheats, which by their leaves represent typical recessive forms.

The flaxes of Cyprus and Crete are characterized by early maturation, large seeds, large flowers, and resistance to fungus diseases.

The grain leguminous crops of the mountain areas of Cyprus, on the other hand, are distinguished by small seeds. A number of peculiar endemic forms, for instance of grass pea, have been discovered here. As a whole, Cyprus and Crete are also rich in endemic forms of wheats. In addition to the liguleless durum wheat there has evolved a unique type of dense eared durum wheat resembling the wheats of North Africa.

The mountain relief here accessible to agriculture determined the presence of a variety of types of cultivated plants. In addition to endemic mountain forms, we meet considerable numbers of forms occurring in the Mediterranean region. Cereals are represented almost exclusively by spring forms.

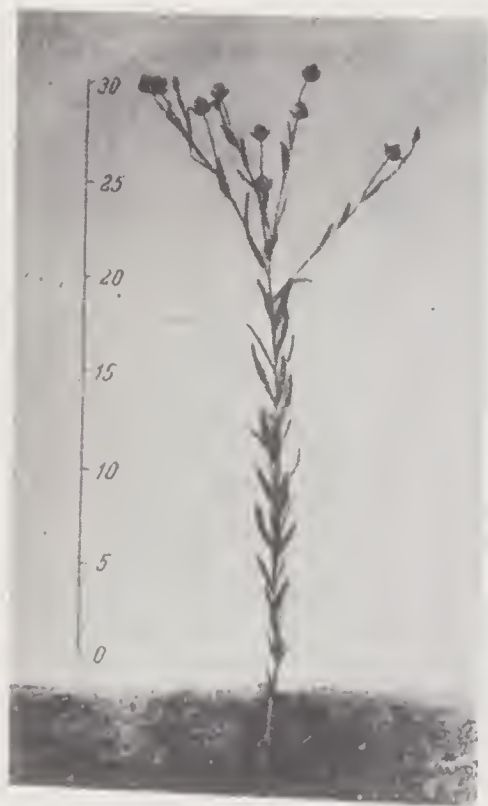


FIGURE 122. Flax - Linum usitatissimum L., Large seed, Morocco

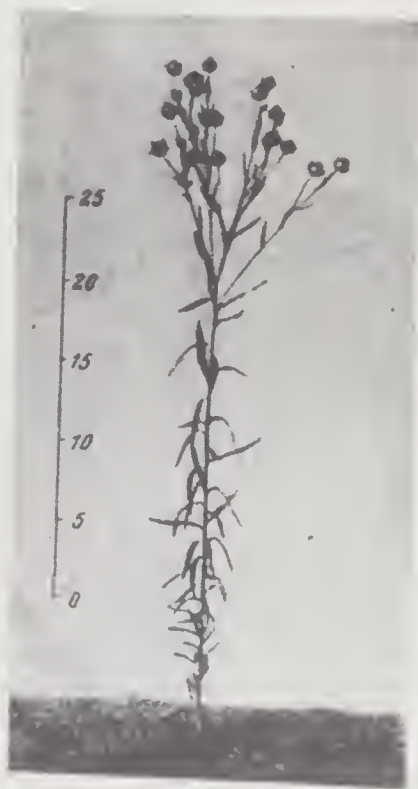


FIGURE 123. Flax - Linum usitatissimum L. Algeria

Table 33

Climatic data for the Island of Cyprus (Nicosia, 35°11' N. lat., Elev. 152 m)

Data	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Precipitation (mm)	74	55	30	25	23	14	3	3	2	17	45	74	365
Av. temp. (°C)	9.5	10.4	12.7	16.7	21.0	25.5	28.3	28.1	25.3	21.4	15.3	11.9	16.8
Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—3.3



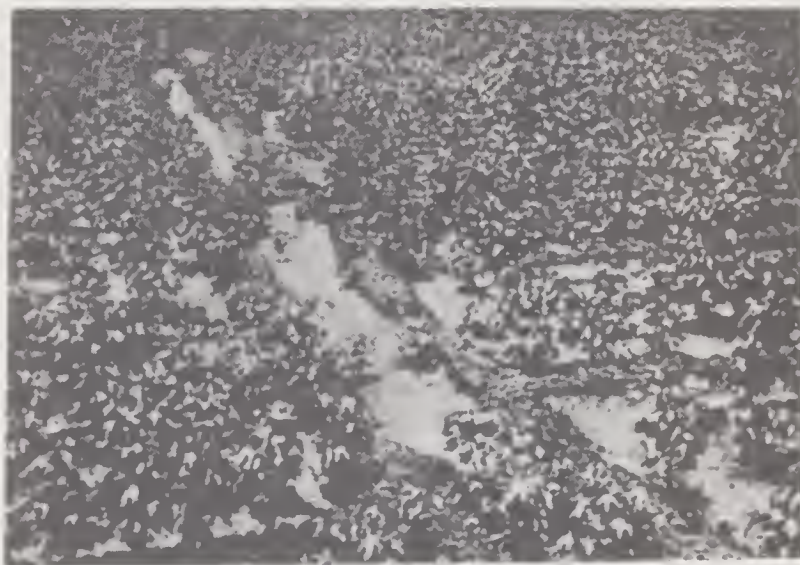
Egypt. Harvesting of wheat



Egypt. Melons and bananas at the
Gura well



Egypt. Native types of Belakhsia



Egypt, Luxor. Irrigation of cotton

29. Egyptian Agroecological Region, Including the Regions of Upper and Lower Egypt and Sudan

Of the countries adjoining the Mediterranean, a special agroecological region is undoubtedly constituted by Egypt and the Sudan bordering on it. Even its geographical position establishes Egypt as an agricultural region with peculiar traits. On the north Egypt is bordered by the Mediterranean sea, on the east and the west the deserts of Libya and Arabia, and on the south, the headwaters of the Nile.

Characterized on the whole by a dry desert climate, Egypt established its agriculture on irrigation. The melted snow waters of the upper reaches of the White Nile carry a large amount of water into the Nile Delta. Later the waters of the Blue Nile arrive, flowing from Lake Tana in Ethiopia (especially rich in ferrous salts).

The waters of the White and Blue Nile unite to meet the requirements of Egypt in agriculture and to a considerable extent in fertilization. The Nile covers immense areas, saturating them with fertile silt. As a result of depending on the melting of snows in the upper reaches of the White Nile and on the arrival of water from the Blue Nile, Egypt periodically suffers either from an excess or insufficiency of water. On the whole, its geographical position ensures exceptionally favorable conditions for the development of irrigated agriculture.

The wide strip beginning from the first cataract of the Nile and extending to the delta over 787 kilometers attains up to 30 kilometers at the widest position and is exceptionally valuable for farming. This is not to mention the delta, which at the largest part of the "fan" is over 600 kilometers in width. The soils are alluvial and very fertile.

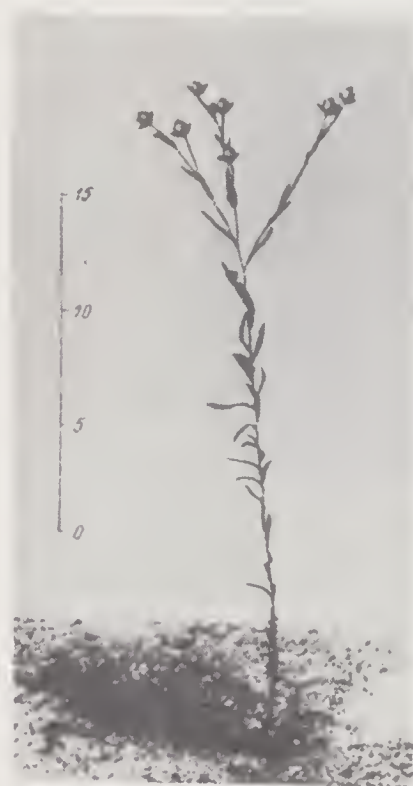


FIGURE 124. Flax—Linum usitatissimum L., large fruit, large seed, Egypt

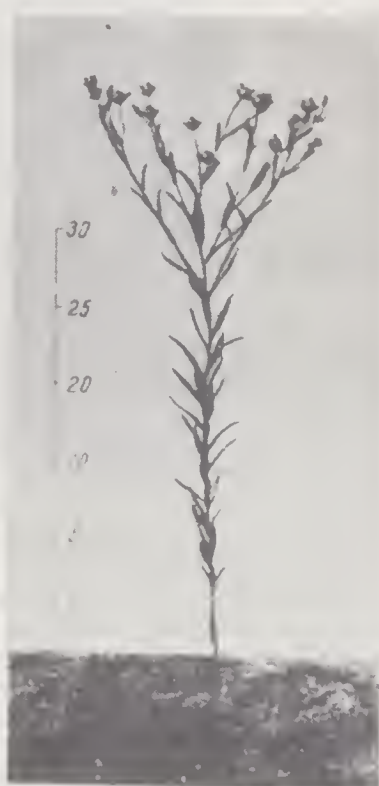


FIGURE 125. Flax—Linum usitatissimum L., Italy



Egypt. Giza. Landscape in the desert



Egypt. Oasis in the desert



Egypt. Halt in the desert



Egypt. Deserts of the Sahara, on the road

The climate of Egypt is favorable for agriculture. There are almost no rains at all, and agriculture is exclusively by irrigation. The favorable conditions for irrigated agriculture already made Egypt the granary of the Mediterranean in antiquity. At the time of ancient Rome, Egypt exported large quantities of grain. The climatic data for the region are presented in Table 34.

Three periods of the year are to be distinguished in Egypt. The first is from June to October, when the floods occur; the following four months — November to February — correspond to the time of sowing and the beginning of growth; the third period comprises March-April-May and part of June, and is the time of growth, maturation, and harvest of the grain. The normal time of sowing of wheat and barley is late autumn.

Within the borders of Egypt, we must differentiate ecologically between the low-lying parts -- Lower Egypt — and the elevated — Upper Egypt. The cultivation of wheat and barley at the present time is concentrated chiefly in Upper Egypt. Sudan, adjacent to Upper Egypt, resembles Upper Egypt in its conditions, being characterized by a small amount of rainfall, high summer temperatures, and the damaging action of dry winds. The continental and desert climate is here in general more markedly pronounced than in Egypt. Agriculture is exclusively by means of irrigation. The sowing of wheat in the Sudan occurs in late autumn.

The peculiar conditions of Egypt and the Sudan made for the evolution of special ecological types of cultivated plants markedly different from the representatives of the true Mediterranean Region. Peculiarities of an ecological origin of Egyptian varieties of wheat and barley are their low height, the fact that they are not recumbent and their rapid maturation. Many local types are characterized by susceptibility to infection by brown and yellow rust, which is apparently connected with the dryness of the atmosphere and the absence of any selective action on resistance to disease. Certain Egyptian types of wheat and barley under Northern Caucasian and forest zone conditions proved to be receptive to a high degree to yellow and leaf rust, including insufficient development of the grain.

As a rule, the Egyptian varieties of wheat react weakly or not at all to vernalization, are resistant to drought, and endure burning heat, particularly in the latter stages of development.

Egyptian flaxes, which resemble Mediterranean varieties in their large flowers, bolls, and seeds, and by their slight branching, are still somewhat unique. As is known, ancient Egypt made use of these for seeds and fiber, manufacturing the finest sorts of cloths.

30. Aegean Agroecological Region

This region embraces both the Aegean Islands in the Eastern Mediterranean and the coastal areas of the western part of Asia Minor and Southeastern Greece.

In general, from the point of view of climate, this region greatly resembles the true Mediterranean one. The rainfall, occurring chiefly in autumn, is nevertheless shifted closer to the summer. The climate is exceptionally mild. The winters are frostless. Unfavorable conditions include the drought occurring during spike development. The soils are often krasnozems (red earths), poor in organic substances. The natural vegetation is the maqui. Such crops as summer leguminous seed fail absolutely here without irrigation, since they suffer during the formative stage of the grain. On the other hand, cotton grows satisfactorily, owing to the adequate warmth. Owing to the dryness, it can be cultivated only with irrigation. This region is particularly favorable for growing wine and olives. The flora of varieties in general is close to that of the Mediterranean, but has a longer drawn out growth period.

Table 34

Climatic Data for the Egyptian agroecological region

Place	Data	Month												Average
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Cairo, Egypt 30°05' North lat. Elev. 30 m	{ Precipitation (mm)	9	5	4	3	1	0	0	0	0	2	3	5	32
	{ Av. temp. (°C)	11.5	13.0	16.0	19.8	23.4	26.1	27.2	27.0	24.3	22.1	17.8	13.3	20.1
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—0.7
Alexandria 31°12' North lat. Elev. 32 m	{ Precipitation (mm)	53	24	13	4	1	0	0	1	7	34	6	7	150
	{ Av. temp. (°C)	13.4	14.0	15.6	17.6	20.3	23.0	25.0	25.6	24.6	22.8	19.1	15.2	19.7
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	3
Port Sudan 19°37' North lat. Elev. 6 m	{ Precipitation (mm)	11	6	2	1	1	0	10	1	0	8	42	17	99
	{ Av. temp. (°C)	22.9	22.8	23.7	26.2	28.9	31.3	33.4	33.5	31.3	28.7	26.9	24.4	27.8
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	10.0
Aswan, Upper Egypt 24°02' North lat. Elev. 128 m	{ Av. temp. (°C)	16.0	17.4	22.6	27.6	32.6	34.3	25.2	24.1	31.7	29.3	22.1	18.3	25.1
	{ Av. abs. annual temp. min. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	3.8
Khartoum 15°34' North lat.	{ Precipitation (mm)	0	0	0	0	3	8	40	56	18	5	0	0	130
	{ Av. temp. (°C)	21.3	23.0	26.2	30.0	22.6	23.0	31.4	30.3	31.2	30.8	26.8	32.3	27.4
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	5.2



Village in the southern part of the island of Crete



Greece. Peasants in Thessaly



Western Cyprus. Ploughing with mules



Sicily. Village near Katania



Algiers. Villagers on the threshing floor (village near Setif)



Algeria. Improved plough, near Sidi bel Abbas



Inhabitants of Central Tunisia.



Inhabitants of mountainous Tunisia

235

Semi-winter forms of wheat exist here which are not found in Algeria, Tunisia, or Morocco. There is no doubt that the factor of insular isolation is at work here, leading to the isolation of unique forms. The chief characteristic of the wheat is the late growing period and frequently the partly wintery quality. The peculiarity of the wheat points to the ecological individuality of this particular region.

31. Inland Oases of Syria, Morocco, and Algeria

As demonstrated by direct study of the flora of cultivated plants in the interior oases of Syria, Morocco and Algeria, these should be separated from the true Mediterranean Region. The Damascus oases in Syria, the oases of Marrakesh and Fez in Morocco, the oases of Libya and the Northern Sahara, are characterized above all by a dry climate and the possibility of cultivation by irrigation only.

The flora of species and varieties under cultivation met with in oases differs sharply from that of the Mediterranean Region. Instead of durum wheats, common wheats are usually grown here. The species introduced into the oases were in addition subjected for hundreds of years to selection under conditions of cultivation on small plots. The assortment of varieties in both the oases of Damascus and North Africa to a large extent came from Southwest Asia. Among common wheats of the Sahara oases, dense-spiked forms with a low, strong and thick stalk have been found, classified by Ducellier as a variety of *Oasicolum* distinguished by high productivity and large number of flowers in the ear.

Durum wheats have also been introduced here, and the flora in general is to a considerable extent foreign and accidental. The important oases have served from time immemorial as commercial centers for nomadic tribes, as a result of which the occurrence of varied forms of both soft and hard wheats and other crops is observed here. The basis of the oasis of Africa is the cultivation of the date palm (*Phoenix dactylifera* L.).

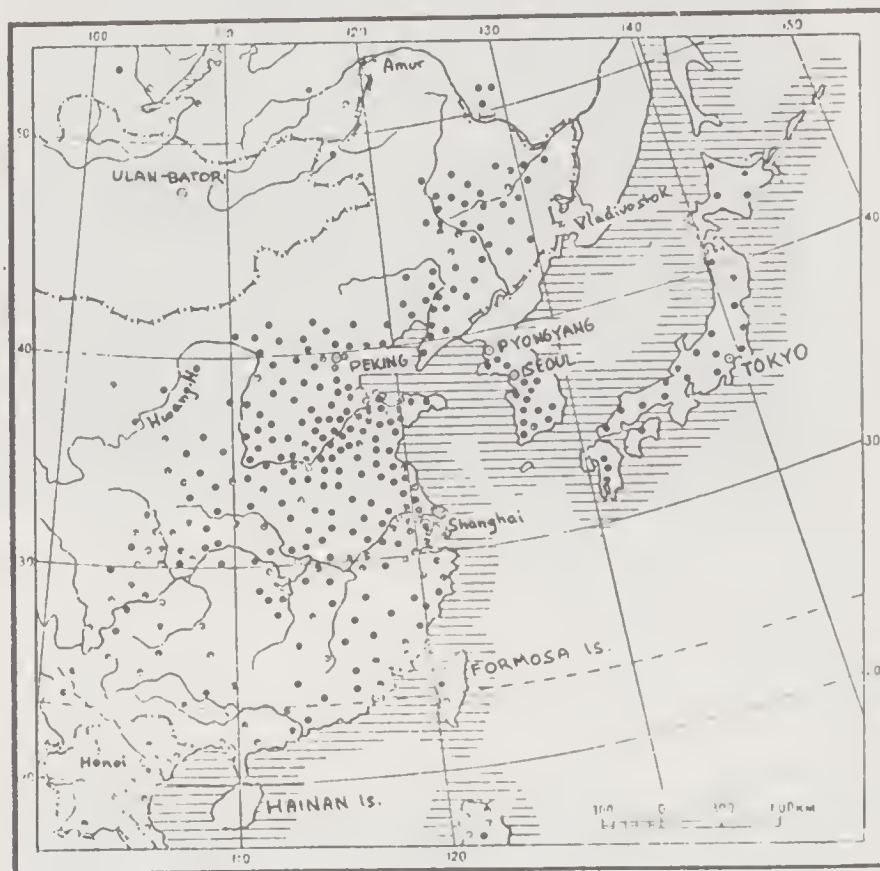
Eastern Asia (in the broad geographical sense)

32. Chinese Japanese Agroecological Region (in the broad geographical sense)

China is a land of great rivers irrigating large fertile loess valleys. The loess soils of the Northern Provinces are the birthplace of Chinese agriculture. The abundance of river waters as well as the periodical droughts encouraged China in the development of irrigated farming.

The fast-flowing rivers with their vast amounts of water formed the basis for the great Chinese agriculture, although at the same time causing constant inundations accompanied by great distress, and the washing away of sown areas and villages over large areas. Particularly perilous in regard to floods is the Yellow River, surging from the mountains and, as it were, suddenly falling precipitously into a broad valley. The flood danger compelled the population from ancient times to have recourse to raising levees on the shores. In a short historical period, the Yellow River has been recorded as changing its bed twelve times. From its earliest days the huge population of China has been constantly forced to invest vast amounts of labor in order to bring their farm lands into a cultivated state.

The total cultivated area of China is estimated at approximately 110-115 million hectares. The exceptional density of population in Eastern China has created a very intensive agriculture, use of fertilizers and diligent care of plants. The fields sown with wheat, which is particularly widespread in North and Central China, occupy nearly 20,000,000 hectares. More than 6,000,000 hectares are devoted to barley, mostly of the hull-less variety. Wheat and barley fields are concentrated



Map 5. Southeastern Asia. Agricultural areas as of 1936 (Cultivated non-fallow areas including gardens and vineyards). Each dot corresponds to 250,000 hectares. Compiled by I. F. Makarov and I. V. Chekan. Edited by Academician N. I. Vavilov

chiefly in the agricultural provinces of Hunan (almost up to 18% of the wheat area of China), Shantung, Hopeh, Anhwei, Shansi, Kiangsu, Szechwan, Shensi.

The northern areas of China adjacent to the Mongolian Peoples Republic are characterized by a dry climate. Here there is a predominance of a pasture economy. In contrast to this, the southern and southeastern areas of China are characterized by an excess quantity of rainfall, from 1,200 to 2,000 mm per year.

Northern China, where the bulk of wheat and barley cultivation is characterized by predominantly loess soils, has a continental climate. Southern China is distinguished by krasnozems (red earths) and a subtropical climate.

According to Papadakis, China, Japan and Korea form a part of two zones, the wheat zone and the citrus zone.



Morocco, Marrakesh



Morocco. Irrigation system, near Marrakesh



Primitive villages of Southern Morocco



Morocco. Villages and native types near Kasbah Tadleh

- 239 Characteristic of the basic wheat areas of North China is the monsoon climate, distinguished by a concentration of rainfall in July and August, and a dry winter and autumn. Most of the rainfall occurs between the months of July and September.

Another distinctive trait of the climate of Northern China, despite the



FIGURE 126. English wheat - Triticum turgidum L., China.



FIGURE 127. Barley - Hordeum vulgare L., var. breviaristatum Vav. China.

comparatively low latitudes, is the low minimum temperatures and their fluctuations, in conformity with the continental climate. The summer is hot. Here wheat often suffers from stem rust during maturation and from drought during the period of ear-development.

The climate of China is particularly favorable for the typical summer cereals, such as corn, sorghum, and millet, and also for leguminous crops - soybean and adzuki bean. For these crops, the hot humid summer and dry autumn are particularly favorable. Cotton also grows here, thanks to the humid warm summer and dry autumn. The natural vegetation is usually represented by the steppe varieties.

In Central China the crops which grow best are also summer cereals and leguminous seed crops (sorghum, corn, soybean, and millets) and also cotton. The soils now consist more of laterites, comparatively poor in organic matter. Southern China is also characterized by dry winters and the concentration of the rainfall in the summer months. Rain is particularly abundant. For this reason, exceptionally rapidly maturing types of wheat must be grown. An important and limiting ecological factor is the occurrence of stem rust. Among the unfavorable conditions for wheat in Southern China are the dry winter, the action of drought in the period of ear-formation, and the action of cold during the early period of

240 development. The main crops are sorghum (*Sorghum vulgare Pers.*), soybean, cotton and rice; for which humid conditions are particularly favorable. A particularly important circumstance for cotton is the dry autumn. The soils are laterite, acidic and poor in organic matter. The natural vegetation is represented by tropical forests.

The climate of Central Japan, where the bulk of the country's wheat and barley is concentrated, is characterized by a comparatively mild winter and plentiful humidity. In contrast to China, the rainfall here is distributed uniformly over the year. Wheats and barley are as a rule sown in the autumn. The principal limiting factors are yellow and brown rust. The latter often caused a sharp reduction in the yield.

In North Japan, flax and peas have successfully been grown after sowing in the spring, and also summer cereals, such as corn and millets and legumes — soybean and *Vigna*; lucerne produces a huge harvest..

To prevent stem rust, the cultivation of early types is particularly appropriate. The soils are brownish.. The natural vegetation is the deciduous type forest.

Despite the large variety of climate in China and Japan, the plants are characterized by a definite uniformity, defined by the basic ecotype. The most characteristic peculiarity is the monsoon climate, manifested by a dry autumn, winter and spring and an excess of humidity in the warm summer months. Accordingly, types of rapidly maturing forms with an accelerated maturation of the grain evolved. The peculiar conditions, intensive cultivation and selection made possible the development of unique forms, which may be grouped in special subspecies of wheats (Figure 126) and barleys (Figures 127-130). As a whole, these are areas favorable mainly for the cultivation of summer plants, such as soybean, millets varieties, sorghum, and corn. As far as the cultivation of barley and the leguminous crops which we are considering are concerned, the Chinese-Japanese agroecological region may be divided into the following agroecological areas:

- 32a. - Regions of Northern China.
- 32b. - Regions of Central China, where the most ancient agriculture of China was concentrated.
- 32c. - Great Chinese Plain.
- 32d. - Red Basin.
- 32e. - Yunnan Plateau.
- 32f. - South-Eastern China.
- 32g. - Agricultural areas of Korea.
- 32h. - Agricultural areas of Japan.

32a. Regions of Northern China

This includes the whole province of Kansu with the exception of its southern part, the northern part of Shensi, and the entire province of Shansi.

The characteristic feature common to this territory is the comparative aridity and relatively severe winters, with absolute minima dropping to -35°C and even lower. As a consequence of the elevation above sea level, the growth period is short. In Kansu, wheat cultivation is practiced at heights of 1,100 meters above sea level. The maximum rainfall occurs in summer (July and August). The winters are snowless. Spring comes late and is comparatively dry. The soils are deep loess. The average annual rainfall is 350 - 600 mm. Harvesting of cereals usually takes place in July. Table 35 presents the climatic data for these areas.

A peculiarity of this territory from the agroecological point of view is its harsh winters, with temperatures dropping to -38° and predominance of northwest and northerly winds. The winters are nearly snowless, with a deeply frozen soil. Spring is dry and comes late. The growth period is short — 130 - 132 days. The soils are exclusively loess. As a rule, only spring wheats and barleys are sown distinguished by swift maturation. Sowing takes place in April and harvesting in July.

32b. Regions of Central China

This comprises the province of Honan and the River Wei-ho. Administratively the latter forms part of the Shensi province.

This area is thought to be the birthplace of Chinese agriculture. A typical merit of the region is the moderate winter, with an absolute minimum of about -15° C. The amount of rainfall in the areas of Central China is illustrated for us by that at Keifeng, Honan Province, which is typical in this respect. Here, on an average over 8 years, the following monthly amounts of rainfall occurred in mm.: I-16; II-16; III-15; IV-27; V-24; VI-41; VII-197; VIII-154; IX-34; X-24; XI-10; XII-9; annual total — 566 mm.

Winter wheats are most widespread, replaced only in the mountain areas by spring types. There are also barleys in the Wei-ho River valley, where the soils are loess, and in Honan, essentially alluvia, with a thin layer of loess. Winter cereals, as a rule, are sown in October. The harvest takes place in July. Spring wheat is sown in April and harvested in July. Typical of both winter and spring wheats and barleys is the fact that they are harvested before the arrival of the rainy season. In connection with this, as a result of natural and artificial selection, rapidly maturing types have evolved. As shown by research, local fast-maturing types of wheat resistant to brown rust and distinguished by accelerated grain ripening are concentrated here. The barleys of the territory are characterized by short beards and small grains.

32c. The Great Chinese Plain

This embraces the wide coastal strip extending from Peking in a southerly direction, comprising the provinces of Hupeh and Shantung; the province of Kiangsi borders it on the south.

The areas of the Great Chinese Lowland, despite the coastal location, are characterized by comparatively cold winters. The absolute minima fall to -20° C. The annual rainfall is 500 - 700 mm. Typical of this area, as of the preceding one, is the monsoon climate, with a concentration of rainfall in summer particularly July and August. Here principally winter wheats and barleys are grown. Sowing of wheat and barley begins in October and continues to November. Harvesting occurs in the second half of July.

Climatic data for this area are presented in Table 36.

Table 35
Climatic data for areas of Northern China

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Liuan, Shansi Province 31° 50' N.lat.	Precipitation (mm)	9	7	11	31	42	49	177	88	51	17	5	7	494
Tai-Ban-fu Shansi Province 39°15' N.lat. Elev. 740m	Precipitation (mm)	6	3	7	15	27	47	114	89	36	15	8	3	370
	Av. temp. (°C)	-8.1	-3.6	4.0	12.2	18.2	23.6	25.5	23.0	16.5	10.5	2.2	-5.2	9.9
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-38.5

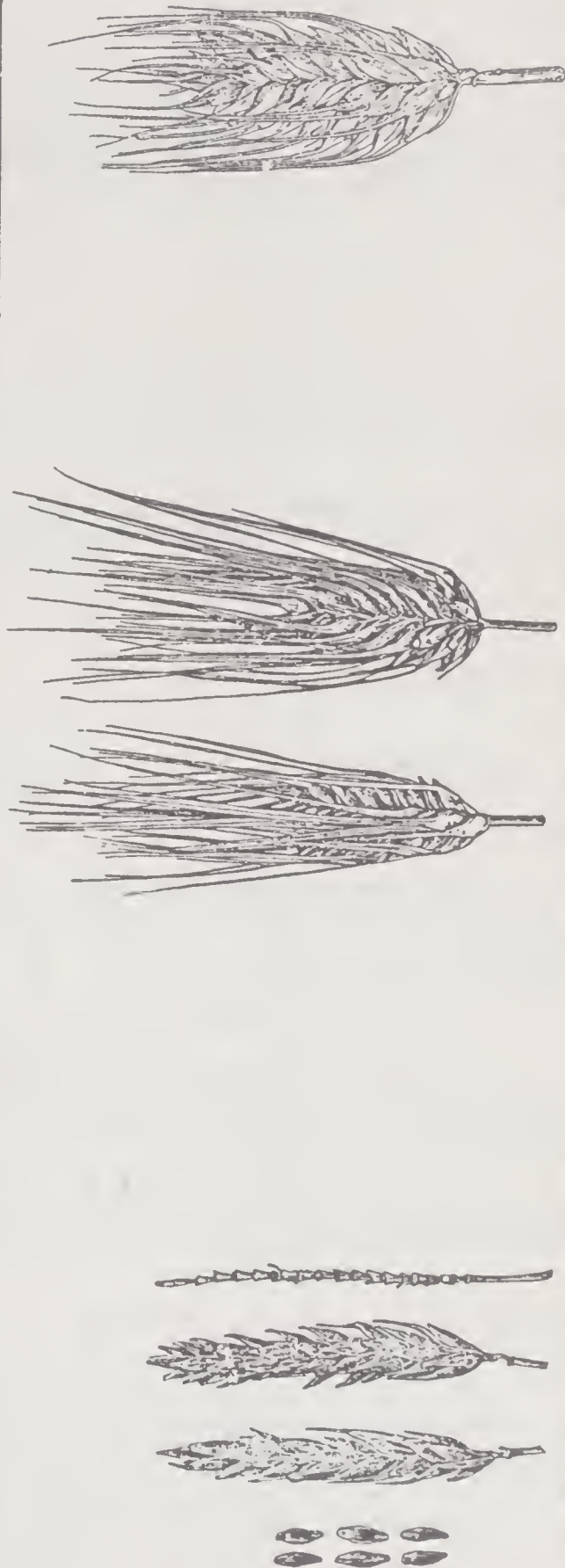


FIGURE 128. Barley—Hordeum vulgare L., var. nigritonsum
Körn, China

FIGURE 129. Barley—Hordeum vulgare L., var. subpyramidatum
Orl., Japan

FIGURE 130. Barley—Hordeum vulgare L., var. brachyatherum
Körn, China.

32d. The Red Basin

This includes the province of Szechwan and the southern part of Kansu and Shensi. Geographically speaking, this area's western part joins Tibet on the west and the Tsinlingshan range on the north. The whole area is located on the middle course of the Blue River (Yangtse) and its tributaries, and is characterized by a rich wild flora. The cultivation of wheat has been concentrated on elevated localities. The Red Basin itself is mainly devoted to subtropical agriculture, particularly cotton. Wheat usually occupies mountain and foothill areas and is predominantly spring, winter forms, not growing high in the mountains. Climatic data for this region are shown in Table 37.

32e. Yunnan Plateau

Administratively speaking, this includes the province of Yunnan and the Western Part of Kweichow. Adjacent to Indo-China and Burma, this area reflects not only the influence of the Chinese hinterland but also the former two countries.

- 243 The cultivation of wheat goes to considerable heights above sea level. The climate is humid. The rainfall is concentrated between May and September. Winter is comparatively dry. Climatic data are presented in Table 38.

32f. Regions of Southeastern China

Administratively this includes the territory of Nanking and Shanghai up to the Nan-Lin-shang Range, the province of Anhwei, as well as Hupeh, Hunan, Kiangsi, Kwangsi, Chekiang, and the eastern part of the province of Kweichow.

This large territory is characterised by a humid climate especially beneficial to the cultivation of rice and typical summer crops, such as soybeans, sorghum, millets, crops, and corn.

In Table 39 we present the climatic data

In respect to the crops we are considering, the areas of Northern and Central China and the great Chinese lowlands, where the basic concentrations of cultivated wheat and barley occur, are of special importance.

A considerable amount of wheat is grown in Szechwan and the high Yunnan Plateau. It is grown least of all in the southeastern low-lying parts.

32g. Agricultural Regions of Korea.

Sown areas under wheat and barley in Korea have greatly increased in recent decades and at the present time amount to 1.3 million hectares*.

Particularly large amounts of barley, the area of which amounts to

* It must be borne in mind that this work was written in 1940 [Editor's note].

Table 36

Climatic data of the Great Chinese Plain

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Peking, Hopeh Province 39°54' North lat.	Precipitation (mm)	5	4	9	22	21	73	264	152	30	19	7	1	607
	Av. temp. (°C)	-4.3	-0.2	0.3	14.9	20.3	25.6	27.6	25.4	19.6	13.6	5.4	-1.9	12.2
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-20.6
Tientsin, Hopeh Province 39°08' North lat.	Precipitation (mm)	4	2	10	17	27	64	174	133	48	16	10	3	508
	Av. temp. (°C)	-4.1	-1.8	4.7	12.7	19.5	23.7	26.1	25.9	20.8	14.2	4.5	-2.4	12.0
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-18.7
Tsingtao, Shantung Province 36°04' North lat. Elev. 75 m	Precipitation (mm)	11	10	20	38	41	85	156	147	84	33	21	16	662
	Av. temp. (°C)	-0.4	0.4	4.7	10.4	16.1	20.0	23.3	21.9	21.2	16.0	8.1	1.4	11.9
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-12.9
Chefoo, Shantung Province 37°34' North lat. Elev. 20 m	Precipitation (mm)	13	11	17	26	33	60	170	156	64	25	29	17	621
	Av. temp. (°C)	-4.7	-0.4	4.4	11.9	18.2	22.7	25.4	25.7	21.6	15.7	8.2	1.6	12.5
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-12.8

- 245 870,000 hectares, of which hull-less barleys take up 50,000 hectares, are grown here. The main concentrations of the fields sown with barley occur in the southern part of Korea and particularly in the Northwest. Wheat farming is practiced further north and particularly in the south-east.

Climatic conditions of South Korea resemble those of Japan, typified by a monsoon climate, with rainfall concentrated chiefly in July-September, and a dry winter, autumn and spring, especially in the south.

From the point of view of the wheat and barley cultivation, Korea could be split into two areas: The mountainous internal and the external areas comprising principally the southern part of the peninsula. The Korean hinterland is distinguished by rather harsh conditions. A large part of the territory is covered with forests. The climate is fairly severe, with a cold winter period. The southern part of Korea has a mild climate which makes it similar to the southern and central parts of Japan and the coastal parts of China.

Climatic data are presented in Table 40.

The types of wheat and barleys of Korea, as of other crops, particularly soybeans and adzuki beans, have been less selected than in Japan, constituting a motley mixture. Among the wheats and barleys there is quite a lot of imported material, for instance from Northeast China, Manchuria, and Japan. The general agroecological barley type is close to the Chinese and Japanese types.

32h. Agricultural Regions of Japan

The total area of wheat and barley under cultivation in Japan totals nearly 1.5 million hectares. In addition, it is almost equally distributed between wheat and hull-less and hulled barley. It is particularly important to note the large area of Japan taken up by six-row hull-less barleys, constituting an important feeding culture. The area under these crops has been calculated at 550-600 thousand hectares in recent years.

The leguminous seeds examined by us are sown during the cold season and cover a comparatively small area. The most widespread of these are peas.

The cultivation of flax for fiber has begun to spread in Northern Japan only in recent decades.

Japan is close to China in climatic conditions, particularly its coastal strip, and is characterized by a monsoon climate. The average annual temperature is not high. The warm Kuro-Siwo current washes the shores of Japan to produce a favorable effect, moderating the climate and prolonging the growth period. The yearly amount of rainfall in Japan averages over 1,000 mm.

Table 41 presents climatic data for the agricultural areas of Japan.

The main area under barley is concentrated in the western part of the island of Honshu. Hull-less barleys are grown predominantly in the southern part of Kyushu. Wheat culture is concentrated in the southwestern part of the island of Honshu and also in the islands of Kyushu and Shikoku.

Table 37

Climatic data for the Red Basin

Place	Data	Month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Chungking, Szechwan Province 29°34' North lat.	Precipitation (mm)	16	20	35	102	141	181	143	131	147	115	50	22	1103
	Av. temp. (°C) ...	9.2	9.9	14.2	19.7	23.1	25.9	28.0	29.1	24.4	19.4	14.8	10.2	19.0
	Abs. min. temp (°C) ..	—	—	—	—	—	—	—	—	—	—	—	—	—1.7
Chengtu, Szechwan Province 30°17' North lat. Elev. 520 m	Precipitation (mm)	6	11	16	47	69	103	143	246	108	49	10	4	812
	Av. temp. (°C) ...	6.8	7.8	12.5	17.4	21.4	24.3	25.8	25.8	21.6	17.6	13.1	8.0	16.8
	Abs. min. temp. (°C) ..	—	—	—	—	—	—	—	—	—	—	—	—	0

Table 38

Climatic data for the Yunnan Plateau

Place	Data	Month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Yunnan-Fu 25° 07' North lat. Elev. 1,980 m	Precipitation (mm)	13	13	14	18	94	155	239	207	136	92	44	15	1040
	Av. temp. (°C) ...	9.1	10.3	15.6	19.9	21.0	22.1	21.1	21.3	18.8	17.3	13.3	9.7	18.4
	Abs. min. temp. (°C) ..	—	—	—	—	—	—	—	—	—	—	—	—	—5.1
Kweiyang, Kweichow Province 26°34' North lat.	Precipitation (mm)	25	26	23	71	178	210	230	102	197	104	52	16	1173

247 Japan is a country of exceedingly intensive agricultural cultivation. The fields are tilled carefully, and organic fertilizers are used in large quantities. In recent decades, selection work has been introduced and progressed well, making possible the appearance of selected types of wheat and barley. Particular interest also attaches to the varied original assortment of Japanese barleys, represented by low forms with a comparatively short ear and short awns. From time to time, quite beardless forms are also encountered. Basically all crops of Japan were borrowed from China, but were subjected to further selection locally. The agro-ecological types of the cereals of China and Japan have much in common, being distinguished by speedy maturation, quick ripening of the grain, small kernels and a strong short straw. Japanese types in general are distinguished by a very low height.

Japan may be schematically subdivided from the point of view of the cultivation of wheat and barley into two areas: the northern area, including the island of Hokkaido and the northern edge of the island of Honshu, where spring sowing is practised to a considerable extent, and the central part, where winter-sown barley and wheat are mainly concentrated.

The sowing of wheat and barley in China, Japan and Korea is normally carried out in late autumn, at the end of October and November; harvesting takes place in June and July in advance of the rainy season.

In conformity with the typical monsoon climate of China and Japan, there has evolved an original cultivated type representing the result of prolonged selection and associated with the intensive cultivation and the role of artificial and partially natural selection.

The bulk of wheat and barley is of the winter and semi-winter types, insufficiently resistant to winter conditions. Even hull-less barley is here represented mainly by winter and semi-winter forms, which is quite unknown in other countries of the world. Cultivation of spring wheats and barleys is also encountered, particularly in the north and high mountain areas.

248 The typical peculiarities of the ecotype of the wheat and barley of Japan and China are the small size, short compact ear and small grain, close to the spherical in shape. From time to time, we find wheat with a thickened and even square-head spike. In the degree of variability of spike thickness, the wheat of China and Japan excels that of all other countries in the world. Thus, in the northern and central areas of China, forms of intermediate density are widespread, as well as an admixture with compact ears. In the humid south-eastern areas, we meet forms with an exceptionally friable ear; the provinces of Kiengsi and Fukien, which are distinguished by a great amount of rainfall (up to 1,000 mm and more) are characterized by wheats of this kind. Still another quite typical peculiarity of wheats and barleys of China and Japan is the shortness, or complete absence, of beard. The wheat is often characterized by numerous flowers. In China we note peculiar beardless durum wheats. The original nature common wheats of China and Japan, which are distinguished by a wide range of varieties as far as ear compactness and shortness or else complete absence of beards and even of beardlike appendages are concerned, as well as the high numbers of their flowers and other characteristics, compels us to place them in a special subspecies.

An outstanding fact in China and Japan is the development of beardless and short-bearded barleys unknown in the basic developmental areas of barley culture in Hither Asia, the Mediterranean, and Ethiopia.

The wheat and barley types of Japan and China show much in common, including quality of ear, beardlessness and shortness of beard, small grain size and dwarfism. Especially peculiar are the completely beardless forms, devoid of even beardlike appendages. There are no such forms in other countries. A considerable quantity of expanded forms of wheat has been found, characterized by a comparatively smaller degree of strewing. In China we also encountered hooded barleys. The overwhelming majority of wheats grown here are soft. Less often we also encounter English wheats — *Triticum turgidum* — and dwarf wheats, and even less often the peculiar beardless hard wheat mentioned above. Another peculiarity of Chinese and Japanese wheats is the astonishing rapidity of maturation, particularly the accelerated development during the later stages — the rapid ripening of the grain. In this respect the Chinese assortment differs from all our usual standards. In addition, a considerable number of local types of Chinese and Japanese wheats are resistant to brown and yellow rust. The defects of the wheats and barleys of the winter and semi-winter group are their poor resistance to winter conditions, insufficiently strong stalk, particularly in wheats, and the small grain.

According to historical records, as far back as the third millenium before our era, wheats and barleys were well known in China and being sown among the principal known cereals during the "Sowing Festival". From the morphology of the ear and grain we may assume that wheats and barleys penetrated into China from India. At any rate, both ecologically and morphologically speaking, Indian and Chinese wheats possess a number of traits in common.

Chinese barleys as a whole constitute a characteristic agroecological group differing sharply from all others.

Among fields sown with rye in Japan, forms of barley have been discovered which correspond to the Japanese and Chinese ecotype wheat, being distinguished by a low height, spherical grain, and almost completely undeveloped beards. Among the peas, forms standing out by virtue of their exceptional dwarfism have been found.

Despite the imported nature in China and Japan of the cultivation of the group of grain plants considered, as attested to by the absence of any close wild forms, or dark-eared forms and the comparatively low number of wheat species in comparison to the Caucasus and Hither Asia, in the course of thousands of years, there did evolve an individual agroecological group of wheats, barley, and rye.

33. Mongolian Agroecological Region.

The climate of Mongolia is influenced above all by its location at the center of the vast Asian continent, its remoteness from coastal shores, and at the same time its accessibility to cold northern air currents. In winter, in the center of Mongolia, the temperature falls to -35 or -40°C . In summer we usually find exceptionally high temperatures, for instance, in Ordus and Alashan, when the soil heats up to 60°C , while the air temperature at times reaches $45-60^{\circ}\text{C}$. In the southern Gobi Desert the soil temperature in summer rises to 65°C and even in April, in Ordus, reaches 37°C .

The eastern half of Mongolia lies under the influence of the Eastern Asiatic Monsoons. The annual rainfall at Ulan Bator is about 100 mm, while in Sivantsiu, at the south of Gobi, it rises to 350 mm.

A considerable surface of the territory of Mongolia is more or less covered by a loess layer. The low-lying sections are characterized by an abundance of salty marshes. From the standpoint of flora, Mongolia is divided into two parts:



Japan. Typical village house on the island of Hokkaido



Japan. Village children on the island of Hokkaido



Japan. Type of village houses on the island of Hokkaido. Roof of rice straw



Japan. Harvesting radish on the island of Hokkaido

Table 39

Climatic data for the areas of South-eastern China

Place	Data	Month												Totals
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Shanghai, Kiangsu Province 31°12' North lat. Elev. 10 m	{ Precipitation (mm)	50	60	87	94	92	188	150	144	120	79	71	63	1198
	{ Av. temp. (°C)	3.3	4.0	7.8	13.4	18.6	22.9	26.8	26.8	22.7	17.4	11.1	5.6	15.0
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—12.1
Hankow, Hupeh Province 30°35' North lat. Elev. 17 m	{ Precipitation (mm)	62	85	137	146	111	249	152	176	135	107	182	60	1601
	{ Av. temp. (°C)	4.5	5.9	10.2	16.6	21.9	26.5	29.7	29.3	24.8	19.2	12.9	7.0	15.8
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—10.8
Huochiu, Anhwei Province 32°22' North lat.	Av. temp. (°C)	5.1	9.1	15.0	19.9	21.1	27.9	28.3	23.0	17.7	12.9	3.5	5.6	16.2
	{ Precipitation (mm)	20	29	54	101	123	155	211	169	100	84	96	14	1096
Ichang, Hupeh Province 30°12' North lat. Elev. 50 m	{ Av. temp. (°C)	5.6	7.0	11.5	17.6	22.4	26.4	29.0	29.0	24.4	19.2	13.4	8.0	17.8
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—7.2

Table 40

Climatic data for the points Seoul and Dalni

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Seoul, Korea 37°34' North lat. Elev. 29 m	Precipitation (mm)	29	34	58	78	84	118	397	242	106	44	48	22	1260
	Av. temp. (°C)	-1.2	-2.1	3.1	10.6	15.9	21.1	24.5	25.4	20.0	13.2	4.9	-2.1	10.9
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-27.8
Dal'ni(Daizem), China 38°56' North lat.	Precipitation (mm)	13	8	18	24	44	45	162	130	102	28	24	12	610
	Av. temp. (°C)	-5.0	-3.5	1.9	9.2	15.2	20.3	23.5	24.6	19.8	13.6	5.2	-2.2	10.2
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-19.4

the forested Northwest and the South, where wooded plant life is absent. In the North, the forests chiefly cover the northern slopes of mountains facing Siberia, from which humid winds arrive. The southern slopes are without forests.

In Table 42 the climatic data for certain points of the Mongolian agro-ecological region are given.

253 Mongolia is a country devoted predominantly to cattle-raising, and farming, only poorly developed, is concentrated chiefly in the mountain and foothill areas of the north-west. In Central Mongolia, as well as in the Tuvia (Tana Touva) Autonomous region of the RSFSR adjacent to it, sown areas exist only in the form of oases and, as a rule, are irrigated. The harsh climate permits no cultivation of winter cereals in Mongolia. Of the spring crops, the principal ones grown are wheats and barleys (Figures 131-132), as well as vegetables. The most important areas occupied by agriculture are in Ulan-Bator, near Hobdo, and along the Salenga River. Less important sections lie in Tsitsinsin-Golu*.

In Southern Kalgon and Kuku-khoto, as well as in the east, agriculture is on an intensive scale, as peculiar to China, chiefly grown being millet, barley and wheat. In its cultivated plant flora the far north of Mongolia resembles Eastern Siberia and Buryat Mongolia, with which it constitutes a single agroecological region. It is highly probable that the old local small-grain, low-height, fast-maturing wheats and fast-maturing Siberian millet and early barleys were introduced from Northern Mongolia. Research by V. E. Pisarev showed definitely the connection between northern agricultural Mongolian culture and Eastern Siberia. The interior regions of Mongolia reflect the influence of China in the types of flora, with inflated forms of soft wheat common. The hull-less barleys of the oases of Hobdo, Ulan-Bator and other places are characterized by a compact ear, and forks instead of beards. In origin they are undoubtedly associated with China.

Among the typical Mongolian common wheats, the expedition led by E. V. Pisarev discovered unique endemic forms with highly pubescent, shaggy leaves and stalk, differing from typical Chinese forms by their larger grain. A defect of these varieties when transplanted to European conditions is their exceptional susceptibility to infestation by yellow and brown rust and powdery mildew.

34. Northeastern China Agroecological Region

The large territory of Northeast China has begun to be intensively ploughed up, particularly in recent decades. The sown areas under all crops have tripled over the last 30 years, amounting to 180,000,000 hectares. A particularly rapid increase was registered by soybean and cereal fields (Figure 133). Here soybean recently occupied over half of the global area of this crop. Sown areas under wheat have recently risen to 1.5 million hectares in North China.

Ecologically speaking, this territory may be subdivided into two: the Northern (34a) and Southern (34b) areas.

* Probably Etsingol [Russian editorial note].

Table 41

Climatic data for the agricultural areas of Japan

Place	Data	Month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Tokyo, Japan Island of Honshu 35°41' North lat. Elev. 20 m	{ Precipitation (mm).....	59	77	103	134	161	172	142	160	256	291	56	57	1603
	{ Av. temp. (°C).....	3.0	3.9	6.7	12.5	15.6	20.2	24.0	25.4	21.8	16.0	10.4	5.2	13.7
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—9.1
Kyoto, Japan Island of Honshu 35°01' North lat. Elev. 50 m	{ Precipitation (mm).....	66	70	110	152	149	236	198	145	221	127	71	55	1600
	{ Av. temp. (°C).....	2.7	3.3	6.2	12.1	16.6	20.9	25.1	26.1	22.1	15.6	9.7	4.6	13.3
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—11.9
Kagosima, Island of Kyushu 31°35' North lat. Elev. 120 m	{ Precipitation (mm).....	83	84	155	232	245	354	235	189	221	130	95	90	2163
	{ Av. temp. (°C).....	7.0	7.0	10.6	15.3	13.5	21.7	25.6	26.4	24.0	19.0	13.7	8.8	16.4
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—6.4
Sapporo, Hokkaido 42°41' North lat. Elev. 15 m	{ Precipitation (mm).....	72	59	59	52	63	58	97	97	138	107	92	92	976
	{ Av. temp. (°C).....	—6.2	—5.4	—1.8	5.1	10.4	14.3	18.9	20.6	16.1	9.4	2.8	—3.2	6.3
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—25.6
Hakodate, Hokkaido Island 41°16' North lat. Elev. 5 m	{ Precipitation (mm).....	66	65	66	63	84	90	129	136	165	127	100	80	1171
	{ Av. temp. (°C).....	—2.7	—2.0	0.6	6.4	10.5	14.4	18.8	—21.4	17.8	11.8	5.5	—0.3	8.5
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—21.7



FIGURE 131. Barley, naked-grain -
Hordeum vulgare L., var. coeleste
L., Mongolia

Table 42
Climatic data for the Mongolian Agroecological Region

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Ulan Bator 47°55' North lat. Elev. 1,325 m	{ Precipitation (mm)	0	0	0	3	5	13	33	28	10	3	3	3	101
	{ Av. temp. (°C)	-23.7	-19.2	-11.3	0.7	8.0	14.6	17.1	15.3	8.1	-0.8	-13.2	-21.3	-2.1
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-48.6
Uliasutai* 47°44' North lat. Elev. 1,719 m	{ Precipitation (mm)	1	0	2	3	27	27	47	40	22	4	4	9	186
	{ Av. temp. (°C)	-22.7	-18.8	-10.2	2.4	9.0	13.2	17.4	14.0	7.9	-2.1	-13.5	-23.5	-2.9
Tsetserlig 47°05' North lat. Elev. 1,687 m	{ Precipitation (mm)	1	1	7	12	28	58	95	22	18	9	5	3	259
	{ Av. temp. (°C)	-14.8	-12.7	-7.4	2.5	9.8	13.0	16.2	14.4	8.3	0.0	-6.7	-14.8	0.7
Kobdo** 47°59' North lat. Elev. 1,300 m	Av. temp. (°C)	-22.9	-18.7	-11.5	2.3	11.5	18.0	19.0	17.4	10.9	2.3	-11.8	-21.4	0.4

* Average for 3 years.
** Average for 2 years.

Table 43
Climatic data for Heilungkiang and Kirin, Northeastern China

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Harbin 46°45' North lat.	{ Precipitation (mm)	5	6	19	15	41	106	171	106	38	19	15	4	546
	{ Av. temp. (°C)	-19.9	-15.5	-6.7	8.5	19.7	13.3	23.1	21.7	13.9	5.3	-7.2	-17.5	6.7
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-40.0
Changchun 43°48' North lat.	{ Precipitation (mm)	10	8	22	31	69	137	216	118	56	41	14	4	726
	{ Av. temp. (°C)	-16.1	-12.0	-5.1	6.9	14.4	19.2	22.4	21.5	14.3	6.1	-5.1	-15.3	4.9
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-34.5

34a. Heilungkiang and Kirin

Northern Manchuria includes the provinces of Heilungkiang and Kirin. The climate of the territory is harsh, with winters characterized by low temperatures and cold north-west winds, as well as by the absence or only poor accumulation of a snow cover. Spring arrives late, and is dry. The rainfall occurs chiefly in June, July and August. The growth period is short, not exceeding 110-120 days. Only spring wheat is grown.

We present the typical climatic data for these areas in Table 43.

34b. Southern Part of Northeastern China

257

This area comprises the southern part of the provinces of Kirin, Liaotung and Jehol. Here the climate is considerably milder than in Northern Manchuria. In the Mukden vicinity, cotton matures, producing a fairly good yield. The absolute minima in Mukden fall as low as -32°C . The amount of rainfall decreases as we penetrate into the continent. The climate is of the monsoon type, with sharp concentrations of rain in summer, and dry autumn and winter months.

We present typical climatic data for these areas in Table 44. As shown by the research of B. V. Skvortsov*, Manchuria grows wheats introduced in the past chiefly from Russia.

258



FIGURE 132. Barley, naked-grain - *Hordeum vulgare* L. var. *trifurcatum*. Mongolia



FIGURE 133. Oats, naked-grain - *Avenum sativa* L. var. *nuda*. China, Inner Mongolia

* B. V. Skvortsov, Manchurian Wheat, Vesten Manchuria (Manchurian Herald); Harbin, 1927, No 4, pp 47-57; No 5, pp 45-55.

259

A particularly large number of Russian types from the European part of the Soviet Union were introduced by immigrants during the construction of the Eastern Chinese railway. These are basically forms of soft wheat or less often dwarf wheat. Only very rarely do we meet with hard wheat here. Thus, the wheat type flora of Northern Manchuria reflects the predominating influence of neighboring Russia. The so-called Manchurian barley represents a typical West European form of the standpoint of the morphology of the ear, the vegetative characteristics, the growth period and other biological properties.

The southern areas of Manchuria have been much subjected during history to the influence of China, chiefly the provinces of Hopeh and Shantung, from which waves of settlers carrying Chinese plants arrived in Manchuria in the past.

Under the influence of natural and artificial selection, there evolved rapidly maturing forms comparatively resistant to cold, but essentially Manchuria, even today, possesses a cultivated flora bearing a foreign character -- in the north originating from the Soviet Union and in the south from China proper.

Southern Europe (in a broad geographical sense)

In the Southern European zone, we must first of all single out, from the ecological point of view, those areas forming part of the true Mediterranean region. This includes the coastal areas of Southern and Southeastern Spain, the farthest southern end of Portugal and the southern coastal areas of Italy. Areas of Southern Greece are combined with the Aegean Islands in a special Aegean agroecological region. The Mediterranean region lies directly adjacent to territories in the south of Europe differing in climate from the true Mediterranean region by a greater degree of humidity during the summer. This includes the following six agroecological regions:

35. Agricultural areas of interior Spain.
36. Portuguese agroecological region.
37. Agricultural areas of Southeastern France.
38. Agricultural areas of interior Italy, except for Lombardy and adjacent areas.
39. Agricultural areas of Northeastern Greece and Macedonia, including also the Maritsa River valley in Bulgaria and the European part of Turkey.
40. Balkan Mountain agroecological region.

The mountain relief of these broad lands and their differentiation into individual entities historically and ethnically isolated from one another oblige us to classify at least the six agroecological regions enumerated above. In carrying out further research, it may be possible that a need for additional subdivision will arise.

All these regions are characterized by certain common agroecological traits. The sowing of wheat is done chiefly in the autumn. The amount of rain is adequate. As a rule, no sharp drop in winter temperatures is observed. The cereal harvest is carried out in dry months. The ecological types of wheat, barley, leguminous seed crops and flax reveal, simultaneously with the presence of a great variety, a certain similarity in growing periods.

260

A single ecotype is encountered in different regions. As a result of cultivation being enclosed within mountain areas, the comparatively backward type of

agriculture, and the influence of ancient migrations, residual species of one- and two-grain forms have been preserved. Oats often grow as weeds in barley and spelt wheat fields, and occur in various forms corresponding to the basic weed-infested crops in their vegetative period and habitus.

35. Agricultural Regions of Inland Spain

The interior areas of Spain, a mountainous region high above sea level, the so-called Mezeta, occupy a large zone bordered on the north (Galicia, Asturia and the Basque) by the Cantabrian and Pyrenean Mountains and separated on the south from the Mediterranean agroecological region by the Sierra Nevada. The average altitudes at which agriculture is concentrated vary here from 400 to 1,000 meters. The Cordoba and Saragossa areas are lower. The chief concentrations of sown cereal fields are in the area of Valladolid, Lamanch, Cuenca and Cordoba. Of the total area of 15.5 million hectares tilled in Spain, the proportion devoted to wheat has recently been 4.6 million hectares, mostly in the hinterland regions. In general, the whole of the hinterland, particularly the more northerly areas, is distinguished by a comparatively dry climate. The rainfall varies from 300 to 550 mm. The climate of the region differs from the Mediterranean region by the fact that the rains are less abundant in winter. Rains fall also in summer. The harmful effect of frost makes itself felt, which is unusual for the Mediterranean; likewise, as in the latter also, the fatal action of stem rust is manifested. Spring crops of the cold season, for instance, potatoes, beet roots, flax and leguminous seed crops (Figures 135-136), grow poorly. The soils are represented by steppe serozems (grey soils) with a more or less alkaline reaction and comparative richness in organic matter. We often note a salinity in the soil. The typical natural vegetation is steppe-like.

Table 45 presents characteristic climatic data for hinterland Spain.

Soft wheat is the principal crop of the region, represented by special endemic forms with a thickened, strong, stout straw*.

261 Hard wheat is also grown. In general, the wheats of the Mezeta are distinguished by drought resistance and a comparatively coarse spike. Quite often they are semi-winter forms. The typical winter forms are but few. Spring forms are also grown, and these are most often sown in the autumn. The cultivation of leguminous drought-resistant seed crops is very widespread. This includes the vetches — *Vicia monanthos* Desf. — and French lentils — *Vicia ervilia* Moensch. The leguminous seed crops, in contrast to the Mediterranean types, have smaller seeds. Oats are represented by the transitory forms, *A. byzantina* to *A. sativa*. Residual forms have still been preserved in the agriculture, such as one-grained forms, grown until today on an area of 40,000 hectares (in 1927). In the Cordoba, Cuenca and Lamanch areas, the cultivation of two-grained forms also exists.

As a whole, this large territory, in contrast to the peripheral sections of Spain in the north and southeast, is noteworthy for comparatively uniform conditions.

36. Portugese Agroecological Region

The climate of Portugal is distinguished by a greater humidity than hinterland Spain. In Coimbra, the rainfall amounts to 914 mm, and in Lisbon to 744 mm. Although most rain occurs in autumn, winter and spring, a sufficient amount also falls in summer. The autumn is dry, and thus convenient for cereal harvesting. The variety of conditions encourages new forms of wheat to arise.

* Forms with a well-filled straw are also found in soft wheats in Georgia. See Dekaprelivich, L. L. The Role of Georgia in the Origin of Wheats. Soobshch. A. M. Gruz. SSR (Papers of the Academy of Sciences of the Georgian SSR), Vol III No 5, 1942, p 449. [Russ. Edit. Note].

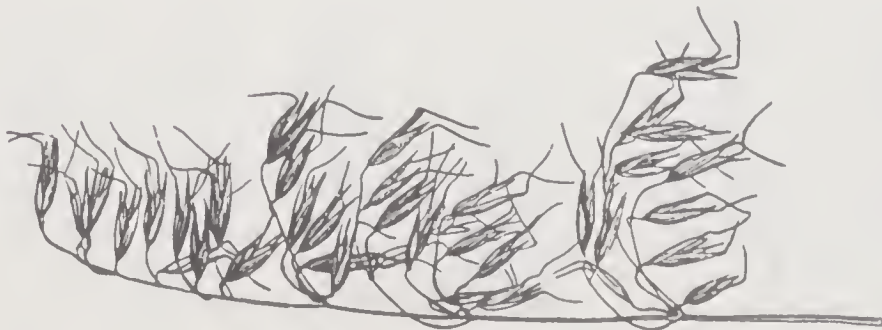


FIGURE 134. Oats, sandy - Avena strigosa Schreb., weed in fields sown with cereals, Portugal



FIGURE 135. Chick pea - Cicer arletinum L., Spain

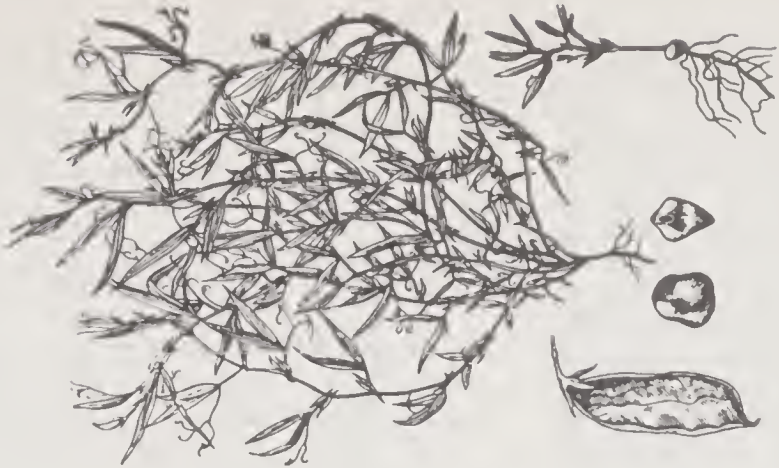


FIGURE 136. Grass pea - Lathyrus sativus, L., Spain

Climatic data of North-eastern China Table 44

Place	Data	Month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Mukden, 41°48' North lat. Elev. 655 m	Precipitation (mm)	5	5	20	28	66	86	160	155	84	41	28	5	673
	Av. temp. (°C)	-13.6	-12.2	-1.4	9.0	15.1	21.4	24.4	23.3	16.7	9.0	-2.1	-8.7	6.7
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-32.9
Yingkow, 40°41' North lat.	Precipitation (mm)	2	6	6	17	36	80	186	137	62	19	12	2	564
	Av. temp. (°C)	-8.9	-8.2	-0.2	8.6	16.9	21.5	24.3	24.4	18.5	11.9	1.5	-5.8	8.8
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-29.4

Climatic data for agricultural areas of Spanish hinterland Table 45

Place	Data	Month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Madrid 40°24' North lat. Elev. 655 m	Precipitation (mm)	34	28	45	47	45	30	12	12	33	45	47	41	419
	Av. temp. (°C)	4.3	6.6	8.6	11.3	15.2	20.3	24.3	23.8	19.1	12.7	9.4	4.5	13.3
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-7.6
Valladolid 41°39' North lat. Elev. 715 m	Precipitation (mm)	20	22	26	27	40	29	9	9	33	31	36	23	305
	Av. temp. (°C)	3.3	6.1	7.4	10.3	14.0	17.7	21.4	21.3	17.5	12.0	7.1	3.8	11.8
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-11.1
Salamanca 40°58' North lat. Elev. 811 m	Precipitation (mm)	20	21	22	25	32	25	14	2	30	33	32	24	280
	Av. temp. (°C)	3.7	6.1	7.8	10.8	14.1	18.9	22.4	21.6	18.3	12.4	7.7	3.9	12.3
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-9.2
Saragossa 41°38' North lat. Elev. 205 m	Precipitation (mm)	17	19	23	29	38	29	15	15	24	33	30	20	292
	Av. temp. (°C)	3.5	18.3	10.6	13.6	17.6	21.4	24.6	24.7	14.6	14.6	9.4	5.7	15.6
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-7.6

Table 46

Climatic data for Portuguese Agroecological Region

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Lisbon 38°42' North lat. Elev. 95 m	{ Precipitation (mm)	92	89	87	66	50	18	4	6	36	83	109	104	744
	{ Av. temp. (°C)	10.3	11.2	12.4	14.2	15.7	19.3	21.1	21.7	20.2	16.8	13.6	11.0	15.7
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—1.5
Coimbra, Portugal 40°12' North lat. Elev. 140 m	{ Precipitation (mm)	93	82	104	99	89	44	18	19	67	110	111	88	914
	{ Av. temp. (°C)	8.8	10.3	11.6	13.2	15.7	18.8	20.6	20.6	19.2	15.4	12.3	9.4	14.7
	{ Precipitation (mm)	62	52	65	58	59	26	5	11	28	56	69	69	560
Campo Major, Portugal 39°02' North lat. Elev. 307 m	{ Av. temp. (°C)	7.8	10.0	12.1	13.8	17.4	21.4	25.2	24.9	22.1	16.7	12.2	8.5	16.0

Table 47

Climatic data for agricultural areas of South-east France

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Lyon 45°45' North lat. Elev. 175 m	{ Precipitation (mm)	36	39	47	61	84	84	73	79	76	97	66	42	781
	{ Av. temp. (°C)	1.7	3.6	6.6	10.9	14.4	18.0	20.1	19.3	16.1	11.0	5.8	1.8	10.8
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—25
Iseo, Switzerland 45°26' North lat. Elev. 401 m	{ Precipitation (mm)	31	39	47	75	90	98	82	85	74	86	67	40	817
	{ Av. temp. (°C)	1.6	3.4	6.0	10.0	13.1	17.0	19.2	18.4	15.2	10.6	5.7	2.3	10.2
	{ Av. abs. annual temp. min. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—19.4
Toulouse 43°37' North lat. Elev. 200 m	{ Precipitation (mm)	45	44	46	67	77	81	38	47	54	58	50	43	650
	{ Av. temp. (°C)	4.5	5.8	8.0	11.3	14.7	18.3	21.2	20.9	17.9	13.0	3.1	4.7	11.9
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—19.3

Portugal may be divided into several agroecological areas.

Considerable quantities of durum wheat are also grown, exceeding common wheat in the north and the mountain areas. In humid areas, the cultivation of Triticum turgidum may be encountered, Common weeds of the wheat fields are Avena strigosa (figure 134) and A. brevis. The climatic data for this region can be gathered from the data for Lisbon, Coimbra and Campo Major (Table 46). Corn and French beans do well in the region. The comparatively cool summer favors these types particularly, depending on the moderating effect of the ocean.

In flora of wheats Southern Portugal resembles the Mediterranean region, the cultivation of hard wheat predominating, in the most humid area - Triticum turgidum.

37. Agricultural Regions of Southeastern France

- 265 Southeastern France is characterized by a considerable elevation above sea level, which causes a considerable variety of conditions. In general this region is characterized by adequate rainfall and a comparatively uniform annual distribution of rain. The climate is more continental in type, the winter cooler and summer hotter. Corn and French beans succumb to the destructive action of summer drought during the flowering period. Thanks to the sufficiently warm climate, cotton may be raised, but since the autumns are rainy, it is hardly rational to grow it.

The soils are more or less neutral in reaction and poor in organic substances. The natural vegetation is the maqui. In winter, the temperature falls fairly precipitately, particularly in elevated areas.

Typical climatic data for this agroecological region are presented in Table 47.

Of 21 million hectares under cultivation in France, the soil of the wheat crop in recent years has been 5.4 million hectares. A considerable part of wheat crops is concentrated in the Southeast of the country.

- 266 The type of cultivated plants and varieties is mesophilic. The wheat of Southeast France is represented chiefly by semi-winter soft forms. Varieties produced by the Villmorin Company (Figure 137), with a comparatively sturdy straw, compact ear and high productivity, are widespread here, although less so than in other parts of France.

38. Agricultural Regions of Inland Italy

The Apennine Peninsula is outstanding in Europe for the exploitation of territory for agricultural crops despite the mountainous nature of the country. Of the total Italian area of 31,000,000 hectares under the plow, corresponding to 48.7% of the total area of the country, over 5,000,000 hectares are devoted to wheat. A very detailed classification of the wheat regions of Italy is given by D. Azzi in his excellent work "Il Clima del Grano dell'Italia." In addition to the true Mediterranean agroecological region, Azzi classes his varieties of ecological regions according to height, and amount and time of occurrence of rainfall. On the whole, we may specify at least three ecological areas in Italy: 1) The Lombardy area; 2) mountainous areas, where wheat occurs at a height of 500-700 meters; 3) the coastal Mediterranean area. A description of the latter has already been given in our discussion of the true Mediterranean region.

The Lombardy areas are distinguished by an adequate amount of rain, rising in the Milan vicinity to 1,000 mm per year. Its distribution is fairly uniform, in contrast to the Mediterranean area. The climate is generally mild. A comparatively slight fall in temperature is observed in winter.



FIGURE 137. Soft wheat - *Triticum vulgare* Vill., var. Villmoran 27, France



FIGURE 138. Barley - *Hordeum distichon* L., var. *nutans*, Schubl. Hanna Loosdorf variety

Table 48 presents climatic data typical of Italy.

In Lombardy, winter soft wheats are the chief produce grown. The type of wheat is generally xerophilous. Semi-winter forms predominate, reacting sharply to vernalization. Among these are types with exceptionally large kernels, constituting extreme standards for *Triticum vulgare*, as far as grain size is concerned, being distinguished by large scales and large spikelets. While being relatively resistant to winter conditions in their native country, . under our conditions, North

Table 48
Climatic data for agricultural areas of Italian hinterland

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Milan 45°28' North lat. Elev. 147 m	{ Precipitation (mm)	62	53	63	87	103	83	71	81	89	120	109	76	1007
	{ Av. temp. (°C)	0.2	3.4	7.8	12.9	17.0	21.8	23.8	22.8	18.9	13.1	6.7	2.0	12.5
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—13.7
Turin 45°01' North lat. Elev. 276 m	{ Precipitation (mm)	56	40	58	112	121	107	59	67	72	91	65	40	888
	{ Av. temp. (°C)	0.3	3.0	7.5	12.0	16.1	20.4	23.1	22.0	18.3	12.2	6.0	1.7	11.9
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—8.4
Bologna 44°05' North lat. Elev. 85 m	{ Precipitation (mm)	40	43	52	58	65	56	35	44	63	88	73	51	668
	{ Av. temp. (°C)	1.5	4.1	8.1	12.8	17.1	21.5	24.6	23.7	19.9	14.2	7.7	2.9	13.2
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—7.0
Padua 45°24' North lat. Elev. 30 m	{ Precipitation (mm)	53	47	61	75	85	87	65	65	75	96	84	63	856
	{ Av. temp. (°C)	1.4	4.0	7.9	12.7	17.0	21.3	23.8	22.8	19.0	13.5	7.4	3.2	12.8
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—
Mantua 45°10' North lat. Elev. 46 m	{ Precipitation (mm)	36	39	44	59	75	65	47	41	59	81	63	45	657
	{ Av. temp. (°C)	1.2	4.1	8.3	13.1	17.5	22.0	24.7	23.8	19.9	13.8	7.4	2.7	13.2
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—

Italian wheats are insufficiently winter-resistant and as a rule succumb when sown in our non-chernozem zone. The spacious Lombardy Valley is characterized by intensive cultivation, with a lavish application of fertilizer and high yields, thanks to the exceptionally favorable climate. The Bologna selection expert, Todaro, has grown, chiefly by the method of individual selection, highly productive forms now widespread in hinterland Italy.

In the mountainous areas, various types of *Triticum turgidum* and *T. diococcum* are grown in considerable quantities. The former is particularly widespread. Two-grain forms are grown mainly on poor shallow soils.

In recent decades the selection expert, Strampelli, has applied the method of crossing rapidly maturing soft Japanese wheats with local Italian wheat to produce highly productive, rapidly maturing forms, such as Ardito and Carlotta Strampelli, which resemble the East Asian wheats in being multiflorous, by rapidity of maturation, low straw and rapid grain ripening. In correspondence to the varied climate, the leguminous seed crops are characterized by a large variation in seed dimensions and rapidity of maturation.

The flaxes of northern and mountainous Italy were the source of Argentinian oil flaxes, which they resemble in ecological appearance.

39. Agricultural Regions of Northeastern Greece and Macedonia

This includes the agricultural areas of the European part of Turkey and the Maritza River valley in Bulgaria. The climate of this part of Greece differs from the Mediterranean in its continental nature, with a hot summer. Here rapidly maturing types of cotton may be produced. The quantity of rainfall in winter is less than usual for the Mediterranean. The summer is dry, but in May-June rains still fall, and thus epiphyte of stem rust quite often develops on the wheat. Corn and French beans suffer from drought during the initial period, and even under irrigation, late sowing is to be preferred in order to delay the time of maturation. Cotton does not always mature. The autumn is frequently rainy, while winter sometimes sets in very rapidly. The soils are intermediate in type between the steppe aerozems (grey earths) and Mediterranean krasnozems (red earths), relatively alkaline and poor in organic substances. The typical natural vegetation is represented by a transition from steppe forms to the maqui. Climatic conditions may be judged from the data for Larisa, in the Thessaly valley of Greece, Salonica, and other places (Table 49). This region includes the most important agricultural areas of the Balkan Peninsula, including the areas of Thessaly, Macedonia, the Vardar River, etc., and the Bulgarian Valley of the Maritza river and its tributaries. Thessaly is the granary of Greece, where large fields sown with cereals and leguminous seed crops are concentrated. The low-lying areas of Macedonia and Bulgaria have a similar agricultural value. Until not long ago, all local types were to be found under cultivation, the chief representatives being productive forms of wheats and barleys. Durum wheat is widespread in Thessaly.

As the elevation above sea level increases, forms occupying an intermediate position between *Triticum turgidum* and *T. durum* predominate. The flora of Thessaly wheat types is of a comparatively varied nature. According to research carried out by Papadakis*, no less than 80 botanical varieties of wheats exist. This is connected with the introduction of wheat from different countries. From the shores of the Black Sea, soft wheats arrived. *Triticum turgidum* is mainly encountered on the slopes of the Pindus Mountains and in the adjoining humid valleys.

* Papadakis, Le Ble du Grec, Larissa, 1931.

Table 49
Climatic data for the agricultural areas of North-east Greece and Macedonia

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Larisa, Greece 38°37' North lat. Elev. 76 m	{ Precipitation (mm)	45	47	36	33	45	38	34	23	26	47	67	48	489
	{ Av. temp. (°C)	5.1	7.4	10.7	14.8	20.2	24.8	27.7	27.4	22.7	17.4	11.1	7.7	16.4
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—13.0
Philipopolis, Greece 42°09' North lat. Elev. 160 m	{ Precipitation (mm)	35	33	38	40	57	62	49	40	38	38	50	33	513
	{ Av. temp. (°C)	0.9	3.0	7.4	12.2	17.3	21.0	23.4	22.8	18.7	13.2	6.7	2.8	12.4
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—18.0
Salonica, Macedonia 40°39' North lat.	{ Precipitation (mm)	36	38	40	48	58	44	24	30	40	51	69	59	537
	{ Av. Temp. (°C)	5.4	7.1	10.1	14.0	19.4	23.5	26.6	25.8	22.0	17.5	11.3	7.8	15.9
Kavalla, 40°55' North lat. Elev. 12 m	{ Precipitation (mm)	69	92	67	49	50	42	17	53	34	21	69	79	642
	{ Av. temp. (°C)	6.3	6.9	9.2	13.9	19.9	23.6	25.6	26.3	21.9	16.9	11.6	8.8	15.8
Uskup, Turkey 41°40' North lat. Elev. 245 m	{ Precipitation (mm)	35	30	19	43	56	57	36	36	30	51	38	48	479
	{ Av. temp. (°C)	—1.4	1.2	7.3	11.8	16.6	20.4	23.2	22.3	19.1	13.9	6.1	1.1	11.8

270 Hard wheats are concentrated chiefly in the valleys. Certain forms of hard wheat obviously came from Asia Minor. Recently very modern selected types have begun to be intensively cultivated, particularly those from Australia, for example, Canberra and Hard Federation. We consider hard wheat (Deves) sown in autumn the typical form for Greece. According to the study of Papadakis, 0.7 of the wheat grown in the Thessaly valley is this typical variety of T. durum var. hordiform (Host.) Koern. In Macedonia and low-lying parts of Bulgaria, there are considerable varieties of both hard and soft wheats. Sowing is carried out chiefly in autumn. Winters are comparatively mild. There is no doubt that a more detailed subdivision into ecotypes will in future be necessary here also.

40. Balkan Mountains Agroecological Region

This region includes the agricultural areas of interior Greece, Albania, Southern and Central Yugoslavia and a large part of the territory of the Bulgarian uplands. As a result of the variability of the mountain relief, the proximity to the ancient breeding grounds of agriculture, and the primitive character of the agriculture, this region is characterized by a great variety of local types. It differs from the preceding region by its greater aridity. Quite often here a dry spring is experienced. In contrast to the Mediterranean region, the rainfall is distributed in a comparatively uniform manner.

Table 50 presents climatic data characteristic of this region. The principal crop here is wheat. In Yugoslavia in recent years, this has occupied nearly one million hectares, corresponding to 27 % of the total sown area. Sowing of wheat and barley is carried out mainly in autumn. In the mountainous areas, large amounts of soft wheats are grown. In the valleys and foothill areas, we quite often meet with T. turgidum. Winter barleys exist in considerable quantities in local agriculture. Soft wheats are frequently represented by the Banat type, i.e., bearded red-grained winter wheats. The flora of types is comparatively motley, containing a large variety of botanical varieties. These areas deserve to be classified in more detail from an agroecological point of view in the future. In the mountain regions, fields of two-grained and even single-grain wheat are met with from time to time. The ecotype of the two-grained varieties here somewhat resembles the Volga type.

Mountain Districts of West and Central Europe

Broad territories of western Europe consist of mountainous regions utilizable to a greater or smaller extent for agriculture. Here we classify the territory including the Carpathian arc, comprising the Hungarian plain, the mountain areas of Czechoslovakia and the southern high-lying parts of Germany, including Bavaria, Wuerttemberg, Baden, Saxony, and Thuringia. Here the Swiss, Austrian and Italian Alps are contiguous. We include in this mountain region the Pyrenees and their extension in north-western Spain, represented by the northern slopes of the Cantabrian Mountains. The convenient mountain plateaus and slopes were here, just as in Southern Asia, the first to be used by the agricultural population. Agricultural cultivation goes back many centuries or even millenia and is of great interest from the point of view of the assortment of plants grown. Residual species of very ancient local types have been conserved in cultivation until today. Ancient spelts of the true type — T. spelta — bi-grained T. dicoccum, single-grained T. monococcum, and English wheat, T. turgidum, are known.

The climatic and soil conditions of this region are less favorable than in the low-lying parts and plains of Western and Central Europe and for this reason, winter-resistant forms evolved particularly in places of high elevation, including

Table 50

Climatic data of the Balkanic Mountain Agroecological Region

Place	Data	Month												Average
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Sofia 42°42' North lat. Elev. 550 m	Precipitation (mm)	27	32	41	54	83	82	68	53	55	55	61	29	640
	Av temp. (°C)	-1.7	0.4	5.3	10.2	15.1	18.2	20.4	20.1	16.1	10.8	4.4	0.3	10.0
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-17.3
Belgrade 44°8' North lat. Elev. 138 m	Precipitation (mm)	33	33	37	60	71	74	61	52	44	56	49	44	614
	Av temp. (°C)	-0.7	1.0	6.6	11.4	16.6	19.7	21.8	21.2	17.1	12.4	6.2	1.9	11.3
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-14.4
Sarajevo, Bosnia 43°52' Elev. 573 m	Precipitation (mm)	53	51	60	76	83	101	65	60	77	89	85	75	877
	Av temp. (°C)	-0.7	0.2	5.7	9.5	13.5	16.5	18.8	18.5	15.0	10.1	5.6	1.0	9.5
Tripolis, Peloponnese 37°31'	Precipitation (mm)	113	87	62	56	57	31	15	19	24	77	123	125	789
	Av temp. (°C)	5.1	6.6	8.9	12.7	17.4	21.5	24.9	24.8	21.3	16.8	10.2	7.0	14.8
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-17.0
Monastiraki, Greece 41°30' Elev. 617 m	Precipitation (mm)	49	72	45	67	68	60	39	36	36	75	71	62	680
	Av temp. (°C)	0.9	2.7	6.7	11.1	16.4	19.7	22.1	21.9	18.3	13.3	6.4	2.5	11.7
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-17.6
Trikkala, Greece 39°33' Elev. 114 m	Precipitation (mm)	85	72	67	50	64	42	19	22	26	76	108	91	722
	Av temp. (°C)	4.9	7.3	11.0	15.2	20.6	24.6	28.1	27.8	23.0	17.4	11.0	7.5	16.5

272

winter forms of Bavarian wheats and unique soft wheats encountered in the Alps. Even single-grained forms are represented, in contrast to the spring forms of Hither Asia and the Caucasus, by cold-resistant and winter forms. Both true spelts and single- and two-grained forms are distinguished by scant soil requirements. The abundant humidity and prolonged growing period led to forms evolving here that possessed considerable resistance to fungal disease, for example to brown, yellow and stem rust and powdery mildew. Forms of an extremely interesting type exist as components of hybridizations.

The mountainous region belonging to West Europe in a wide geographical sense may be divided into five agroecological regions:

41. Pyrenean Region, including Cantabrian Mountains.
42. Alpine-Tyrolese region, including all of Switzerland, the Italian Alps and mountain parts of Austria.
43. Carpathian Region, including the whole of the Carpathian mountain arc.
44. Southern uplands of Germany, including Bavaria, Wuerttemberg, Thuringia, Saxony, and Schwabia.
45. Czechoslovakian upland agroecological region, including the spurs of the western Carpathians.

41. Pyrenean Agroecological Region

The Pyrenees Region, including the Cantabrian Mountain areas, comprises, from the administrative point of view, Galicia, the Asturias, the Basque area, and the French Pyrenees. The region is characterized by good humidity and rainfall amounting to 1,000 mm or more — the humidity is even often excessive, for example, in Bilbao (1,230 mm). The climatic data for the Pyrenean agroecological region are presented in Table 51. In contrast to the dry hinterland part of Spain, the northern mountain slopes and the coastal territory of Galicia, the Asturias and the adjacent Basque area are distinguished by a rich meadow and forest vegetation. The greatest amount of rainfall occurs in autumn. A favorable condition for the cereal harvesting is the comparatively lower humidity of the summer.

273

Agricultural cultivation began here in prehistoric times, represented by characteristic species, including endemic ones. In Asturias is concentrated an original group of true spelts — *T. spelta* — in a large variety of forms. In contrast to the chiefly winter forms of Bavaria and Belgium, the Asturian spelts are late spring forms.

In the Asturias and particularly in the mountainous part of the Basque, cultivation has up to now concentrated on bi-grained forms. In Galicia, the cultivation of 14-chromosome oats, *A. brevis* and *A. strigosa*, is widespread, as is rye. The area, as it were, is a rye kingdom, to judge from the wide distribution of this crop. On the whole it is a domain of endemes; for instance, in sandy oats, we may follow the entire development from wild to cultivated forms.

A. brevis and *A. strigosa* undoubtedly were introduced here independently into cultivation. Leguminous seed crops are represented chiefly by small seed forms, differing from the usual Western European large seed types, and possibly connected in origin with Southwestern Asia. In the Basque region, attention is specially attracted by oats distinguished by resistance to rust and smut. The long growing period, adequate quantities of moisture, the moderate climate which favors the development of fungal diseases, these encouraged forms comparatively resistant to rust and powdery mildew to evolve, all characterized by comparatively late maturation and small size of grains.

42. Alpine-Tyrolian Agroecological Region.

The Alpine-Tyrol mountain region, including the Swiss and Italian Alps and the mountainous part of Austria, is a territory long peopled by farmers. In the remnants of the stilt-dwellings of lakes, traces of farming have been found belonging to the Bronze Age.

The Alpine-Tyrolese region is characterized by a cold climate, particularly in the higher areas. Both spring and winter wheats and large quantities of rye are grown. A fair amount of spelt has been preserved to this day, and single-grained and English wheat are also grown (T. turgidum).

In the Swiss areas, thanks to intensive cultivation and a high level of agro-technology, there evolved valuable soft winter wheat types, distinguished by resistance to winter conditions and high productivity. Some extreme types proved to be relatively durable even in the non-chernozem regions of the USSR. The soils are podzol and stony. The amount of rainfall is excessive. Thus, in Zurich, it amounts to 1,100 mm, in Lausanne 1,004 mm, and in Berne 922 mm annually. The absolute temperature minima are comparatively low: at a height of 500-600 meters, they do not exceed -14 or -15° C. Climatic data for this region are shown below and in Table 52.

Splügen, Switzerland: 46°32' north latitude, 1,470 m above sea level:

Temperature of warmest month (°C)	13
Temperature of coldest month (°C)	7.1
Absolute temperature minimum (°C)	- 30.5
Number of days with temperature above 5°C	157

43. Carpathian Agroecological Region

The Carpathian arc includes various centers of agricultural cultivation affording a great deal of interest because of their floral types, which has so far been insufficiently studied. Climatic data typical of this region are described in Table 53.

274

One of the most remarkable types of bearded winter red-grained wheats, occupying a large area in Europe and North America, is connected with the locality called the Banat. In the mountainous areas, to this day, the two-grained English wheat, T. turgidum, has remained in cultivation. Large quantities of rye, barley and oats are grown here.

On the whole, the region is characterized by adequate amounts of rainfall, moderate temperatures, and thanks to the elevation, fairly severe and cold winters.

44. Mountain (Upper) Germany

This includes Bavaria, Saxony, Schwabia, Wuerttemberg and Thuringia. The climatic conditions of the territory may be gathered from the data in Table 54 (see p 274).

These areas of southern Germany have up to the present preserved relics of their original crops. True spelt — T. spelta — is grown here on tens of thousands of hectares. Individual plots are devoted to the cultivation of single-grained, two-grained and English wheat. We have all the grounds for believing that this

Table 51

Climatic data of the Pyrenean Agroecological Region

Place	Data	Month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Oviedo, Spain 43°23' North lat. Elev. 244 m	{ Precipitation (mm)	70	75	106	94	67	67	50	40	78	88	94	96	922
	{ Av. temp. (°C)	6.5	7.6	8.9	10.5	13.0	15.7	17.5	17.9	16.8	12.9	9.8	7.9	12.1
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—10.4
Bilbao, Spain 43°15' North lat. Elev. 16 m	{ Precipitation (mm)	116	95	109	111	77	84	62	55	89	136	143	136	1212
	{ Av. temp. (°C)	8.7	10.4	11.1	13.3	15.8	18.8	20.8	21.3	19.6	15.7	11.8	8.9	14.7
	{ Av. abs. annual temp. min. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—3.8
Pampeluna, Spain 42°49' North lat. Elev. 463 m	{ Precipitation (mm)	66	58	57	66	61	65	36	32	46	60	91	59	697
	{ Av. temp. (°C)	3.7	6.5	8.0	10.3	13.7	17.6	20.0	20.7	18.1	12.8	8.5	5.2	12.1
	{ Av. abs. annual temp. min. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—9.5
Santandar, Spain 43°29' North lat. Elev. 14 m	{ Precipitation (mm)	71	52	58	70	59	50	42	53	71	107	101	93	827
	{ Av. temp. (°C)	8.6	9.5	10.5	12.1	13.8	16.8	18.6	19.2	18.0	14.9	12.0	9.5	13.6
	{ Av. abs. annual temp. min. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—
Jaca, Spain 42°36' North lat. Elev. 829 m	{ Precipitation (mm)	31	46	53	76	67	83	50	58	77	69	71	32	723
	{ Av. temp. (°C)	3.2	4.2	6.0	7.5	13.3	16.5	19.8	20.4	16.2	10.4	6.9	3.9	10.6
	{ Av. abs. annual temp. min. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—
Huesca, Spain 42°07' North lat. Elev. 504 m	{ Precipitation (mm)	29	41	48	56	63	41	27	33	69	59	51	27	544
	{ Av. temp. (°C)	3.6	6.5	8.4	11.2	15.3	19.3	22.8	22.6	19.0	13.4	8.2	3.9	12.9
	{ Av. abs. annual temp. min. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—9.4
Foix, France 42°58' North lat. Elev. 433 m	{ Precipitation (mm)	72	72	76	102	108	100	53	60	69	75	72	70	929
	{ Av. temp. (°C)	3.7	5.1	7.3	10.1	13.5	17.0	19.4	19.1	16.1	11.6	7.0	4.0	11.1
	{ Av. abs. annual temp. min. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—
Bagnères- de-Bigorre, France 43°04' North lat. Elev. 547 m	{ Precipitation (mm)	107	103	121	150	155	143	77	81	104	115	111	108	1373
	{ Av. temp. (°C)	9.1	5.3	8.6	9.5	11.9	15.6	17.7	17.8	15.3	10.7	8.7	3.7	10.6
	{ Av. abs. annual temp. min. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—

is the most ancient agricultural region of Germany. Under the conditions of an old cultivation, comparatively unfavorable thin mountain soil conditions, and a moderate climate, there developed local types with comparatively few requirements. In recent decades, a great deal of selective work was launched here for ameliorating the true spelt by crossing it with soft wheat. The hybrids are distinguished by a strong ear and suitability for mechanized harvesting, and are of considerable interest because of their winter resistance, strong straw, and comparative resistance to brown and yellow rust. The German mountain single-grainers are distinguished by their late maturation or even by a winter habitus, undoubtedly constituting a special group. The two-grained varieties of Germany are characterized by comparative resistance to cold.



FIGURE 139. Soft wheat—*Triticum vulgare* Vill.
Robusta var. Holland



FIGURE 140. Sown oats—*Avena sativa* L.,
thick fruit form. Western Europe

45. Czechoslovakian Agroecological Region

The whole of Czechoslovakia is essentially an upland country. In climatic conditions, it is characterized on the whole by adequate or even sometimes excessive rainfall. Winter conditions are more favorable than in the steppe and forest-steppe zones of the European part of the USSR. The climatic data of the different sections of this region are given in Table 55.

Types of flora are fairly varied, and in the mountain areas composed to a considerable extent of ancient local types of fundamental selection interest.

Table 52

Climatic data of the Alpine-Tyrol Agroecological Region

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Geneva 46°12' North lat. Elev. 405 m	{ Precipitation (mm)	41	51	50	64	75	75	80	83	91	121	84	57	872
	{ Av. temp. (°C)	0.0	2.0	4.9	9.4	13.3	17.1	19.5	18.3	15.1	9.5	4.9	0.9	9.6
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—16.7	—
Berne 46°57' North lat. Elev. 572 m	{ Precipitation (mm)	43	52	58	70	81	104	99	102	83	92	67	57	908
	{ Av. temp. (°C)	—2.3	0.1	3.2	8.2	12.0	15.5	17.6	16.6	13.4	7.6	2.7	—1.7	7.7
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—12.3
Zurich 47°23' North lat. Elev. 475 m	{ Precipitation (mm)	46	53	65	88	108	122	133	120	122	97	61	75	1090
	{ Av. temp. (°C)	—1.4	0.8	3.8	8.8	12.9	16.5	18.4	17.3	14.2	8.4	3.6	—0.6	8.5
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—18.2
Lausanne 46°31' North lat. Elev. 553 m	{ Precipitation (mm)	48	55	63	67	82	97	93	102	112	123	81	65	988
	{ Av. temp. (°C)	—0.5	1.6	4.2	8.7	12.6	16.2	17.4	17.5	14.7	9.1	4.5	0.6	8.9
	{ Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—10.4
Innsbruck 47°16' North lat. Elev. 600 m	{ Precipitation (mm)	39	42	49	58	69	101	127	114	87	59	41	52	838
	{ Av. temp. (°C)	—3.3	—0.6	3.7	8.8	12.9	16.2	17.8	16.9	13.9	8.8	2.7	—2.6	7.9

Rye and oats are grown here in large quantities. Oats are represented by original local types, including giant forms. Of particular interest are the beer-brewing varieties of barley of Czechoslovakia (Figure 138). It was from here that the famous Hanna Moravskaia type radiated to different countries.

Northwest European Region (in a Broad Geographical Sense)

Despite the huge territory occupied by the lowlands of Western Europe, including the Soviet-Baltic Republics, a large part of Germany and Belgium, Holland, Northern France, Great Britain, Ireland and all of Scandinavia, the region is still characterized by an agroecological uniformity. Geobotanically, this forest region is distinguished by coniferous forms in the most northerly areas, and by deciduous forests in the southern areas. A great part of contemporary agricultural lands was covered in the past by forests. The soil is podzolized and acidic; as a result of the abundant rainfall, organic substances decompose readily and the soils as a rule require fertilization. The climate of the section is moderate and comparatively humid in the west but drier as we progress eastward. In general it is a littoral climate to a considerable extent. Despite the moderate winters, the summer is insufficiently hot. The rainfall is distributed fairly uniformly over the year.

The areas forming part of this territory usually suffer no drought. The winters are severe with extremely low temperatures falling below 0°C , but nevertheless mild in comparison with Eastern Europe and the northern areas of the European USSR. The differences between spring and winter crops are quite marked. The growth period is 150-180 days. Maximum rain falls in the summer. Thus the curve of temperature-increase coincides with the increase in rain.

Huge quantities of winter wheat, winter rye, and spring oats are grown. Fields sown with winter barley are also found in considerable numbers. Plants requiring cold-season weather for normal development, such as potatoes, sugar beets, flax, peas, and beans grow excellently. This is the domain of the potato. The greatest area in the world devoted to potatoes is concentrated in Western Europe and adjoining areas of the USSR. The main production of sugar beets is also concentrated here.

In the past, large quantities of flax were grown for fiber. Clover and meadow grasses grow excellently.

As a whole, the climate of Western Europe is exceptionally favorable for the growth of annual plants. Thanks to the old intensive cultivation, the use of organic and mineral fertilizers, and the high level of agrotechnology, there evolved exceptionally productive local and selected types. In recent decades, old local types have yielded to new selected types obtained both by individualized selection and crossing.

Definite laws are obeyed in the geographical location of the crops: as we proceed westwards, under milder conditions of winter, winter wheat agriculture predominates. Towards the east and in the extreme north of Germany, the Soviet Baltic Republics and Poland, large areas are occupied by winter rye. The spring types of barley, oats and leguminous seed crops are distinguished by comparatively late maturation, strong development, hygrophilia, and large grains. They respond very well to fertilization and in general are distinguished by high productivity. In the past

Table 53

Climatic data of the Carpathian Agroecological Region

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Sinaya, Rumania 45°21' North lat. Elev. 860 m	{ Precipitation (mm)	25	27	38	57	81	114	97	82	66	48	37	23	690
	{ Av. temp. (°C)	-4.0	-1.7	4.3	9.6	15.4	17.8	19.9	19.0	14.9	10.0	9.2	-1.1	9.0
	{ Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-22.7
Vatra Dornie, Rumania 47°21' North lat. Elev. 789 m	{ Precipitation (mm)	21	27	43	49	81	120	135	88	52	46	38	23	731
	{ Av. temp (°C)	-6.4	-5.6	-0.9	5.0	9.4	12.7	14.2	13.5	9.8	5.5	-0.9	-5.1	4.3
Czernovitz 48°17' North lat. Elev. 243 m	{ Precipitation (mm)	24	21	34	64	74	94	94	66	64	49	34	23	641
	{ Av. temp. (°C)	-5.1	-2.9	1.6	8.1	14.6	17.6	19.4	18.5	14.3	8.2	1.9	-2.3	7.8

Table 54

Climatic data of uplands of Upper Germany

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Nuremberg 49°27' North lat. Elev. 309 m	Precipitation (mm)	35	31	39	35	56	66	76	58	51	43	89	43	572
	Av. temp. (°C)	-1.4	0.4	3.4	8.1	13.2	16.8	18.2	17.2	13.5	8.8	8.5	0.1	8.4
	Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-27.8
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	226
Erfurt 50°59' North lat. Elev. 200 m	Precipitation (mm)	26	27	35	33	53	64	73	55	48	43	33	30	520
	Av. temp. (°C)	-1.6	-0.1	2.9	7.3	12.3	15.6	16.9	16.1	12.9	8.2	3.2	0.0	7.8
	Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-29.1
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	221
Marburg 50°49' North lat. Elev. 200 m	Precipitation (mm)	44	40	45	34	51	57	69	59	46	53	48	56	602
	Av. temp. (°C)	-1.3	0.4	3.2	7.6	12.3	15.7	16.9	16.0	12.8	8.0	3.4	0.1	7.9
	Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-16.4
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	—
Wurtzburg 49°48' North lat. Elev. 179 m	Precipitation (mm)	36	24	41	34	53	61	68	52	45	44	42	46	546
	Av. temp. (°C)	-0.8	1.0	4.1	8.7	13.4	17.0	18.3	17.2	13.6	8.6	4.1	0.9	8.8
	Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-26.5
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	—
Munich 48°09' North lat. Elev. 530 m	Precipitation (mm)	39	39	46	71	91	121	116	99	94	57	44	45	861
	Av. temp. (°C)	-2.1	-0.2	3.2	7.7	12.5	15.9	17.7	16.9	13.3	8.1	2.9	-0.7	7.9
	Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-26.4
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	222
Stuttgart 48°46' North lat. Elev. 255 m	Precipitation (mm)	35	35	45	50	63	82	84	65	81	49	44	44	857
	Av. temp. (°C)	0.3	2.0	5.3	9.6	13.9	17.4	19.0	18.2	14.7	9.7	5.2	1.8	9.7
	Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-26.0
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	258

Table 55

Climatic data of the Czechoslovak Agroecological Region

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Prague 50°05' North lat. Elev. 197 m	Precipitation (mm)	21	22	27	39	58	70	63	55	42	30	30	23	480
	Av. temp. (°C)	-1.1	0.4	3.7	8.9	14.0	17.8	19.3	18.7	14.8	9.5	3.8	0.3	9.2
	Av. abs. annual temp. min. (°C)...	-	-	-	-	-	-	-	-	-	-	-	-	-15.9
Brno 49°12' North lat. Elev. 205 m	Precipitation (mm)	25	24	31	36	57	69	68	65	39	40	36	30	520
	Av. temp. (°C)	-2.6	-1.0	2.9	9.7	13.6	17.3	19.1	18.3	14.5	9.2	2.9	-1.7	8.5
	Av. abs. annual temp. min. (°C)...	-	-	-	-	-	-	-	-	-	-	-	-	-16.9
Jihlava Czechoslovakia 49°24' North lat. Elev. 530 m	Precipitation (mm)	33	28	41	46	62	84	82	67	49	44	33	36	605
	Av. temp. (°C)	-3.7	-2.2	0.7	6.1	11.1	15.4	16.7	16.2	12.1	7.3	1.5	-2.6	6.6
	Av. abs. annual temp. min. (°C)...	-	-	-	-	-	-	-	-	-	-	-	-	-19.2
Gorini, Morvaska, Czech. 49°36' North lat. Elev. 485 m	Precipitation (mm)	75	79	86	98	116	195	195	146	107	103	76	75	1351
	Av. temp. (°C)	-3.5	-2.9	0.2	5.1	10.1	14.1	15.4	15.3	12.2	7.7	1.6	-2.3	6.1
	Av. abs. annual temp. min. (°C)...	-	-	-	-	-	-	-	-	-	-	-	-	-21.0
Staryi Smokovets 49°08' North lat. Elev. 1,018 m	Precipitation (mm)	41	38	47	73	85	97	101	100	87	75	72	39	855
	Av. temp. (°C)	-3.8	-4.4	-0.2	3.9	9.9	10.3	14.6	13.8	10.2	5.8	1.4	-3.5	4.8

- 281 decade, we have observed a decisive transfer to hybrids of English Squarehead with local forms. In Germany evolved a peculiar type of compact-ear wheat — the "Dickkopf". Rye is represented over large areas by the standard Pectus variety, with strong stalk and compact productive ear. Winter wheats and to some extent rye of Western Europe, which are completely resistant to winter at home in their motherland, under conditions of the European USSR usually have insufficient winter resistance and are generally frozen out. The spring types of the cereals of Western Europe are comparatively late for the European USSR. Of exceptional value are the two-row West European brewing barleys, of which the group of compact-ear varieties is distinguished by an erect stalk. Great importance has been acquired by West European selected types of oats which proved to be suitable for sufficiently humid areas of European USSR.

The large territories of Western Europe may be divided into five agroecological regions:

46. Northwestern French lowland agroecological region, including Belgium.
47. Northern lowland German agroecological region.
48. Baltic agroecological region, comprising Northern Poland, Kaliningrad region of the RSFSR, Lithuanian SSR, Latvia SSR, Estonian SSR, and the southern coastal part of Finland.
49. Littoral Western European agroecological region, including the lowlands of Great Britain, Ireland, Holland, and Denmark, the southern coast of Sweden and southern coastal low-lying narrow strip of Norway.
50. The Scandinavian agroecological region, comprising the areas of interior Sweden, Norway, and Finland.

46. Northwestern French Lowland Agroecological Region, Including Belgium

- 282 This region includes the northern and western low-lying parts of France, including Bretagne and Aquitaine, i. e., the areas located between the Garonne river and the Pyrenees. As a whole, this large region is characterized by comparatively mild winters and humid climate. In the coastal part of the territory, winter is so mild that growth continues almost uninterruptedly throughout the year, and in winter cattle are driven out to green grass pasture.

In the central part, near Paris, the temperature is lower. The absolute minimum in Paris over 50 years was recorded as -25.6°C . The average of the yearly absolute minima over 50 years was -11.3°C . Papadakis differentiates three climates in low-lying France: the climate of Paris, of Bretagne, and of Aquitaine.

We present typical climatic data for this region in Table 56 (see page 276).

The climate of Bretagne is particularly favorable for the development of a grazing economy, thus resembling Tasmania and New Zealand, with a typical littoral climate. Winter wheat suffers from excess winter humidity, is affected by yellow rust and also lies prone. There are nearly no frosts or drought. This is the most favorable climate for cultivating potatoes. For the sugar beet, however, it is excessively humid. Peas and beans succeed very well, but their harvest is attended with difficulties. Clover and meadow grasses grow particularly well. The soils are podzolized, acidic and comparatively rich in organic matter. The natural vegetation is the deciduous forest.

Table 56

Climatic data of the Northwestern French Lowland Agroecological Region, Including Belgium

Place	Data	Month												Σ °C °C °C
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Nantes 47°15'North lat. Elev. 41 m	{ Precipitation (mm)	69												767
	{ Av. temp. (°C)	4.6	5.5	6.9	5.2	5.6	6.8	4.9	6.1	6.4	9.1	8.9	7.6	11.2
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—16.0
	{ Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	316
Paris 48°49'North lat. Elev. 50 m	{ Precipitation (mm)	38	33	40	42	51	59	54	53	50	57	46	43	566
	{ Av. temp. (°C)	2.3	3.6	5.9	9.9	13.0	16.5	18.3	17.7	14.7	10.1	6.8	2.7	10.1
	{ Av. abs. annual temp. min. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—11.3
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—26.6
Rouen 49°26'North lat. Elev. 40 m	{ Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	266
	{ Precipitation (mm)	54	46	48	45	55	63	64	64	65	69	63	64	699
	{ Av. temp. (°C)	2.9	4.1	5.8	9.7	12.8	16.2	18.0	17.4	14.8	10.4	6.1	3.5	10.2
	{ Av. abs. annual temp. min. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—12.9
Eekloo, Belgium 50°48' N. lat. Elev. 100 m	{ Precipitation (mm)	61	54	59	58	55	67	86	71	69	71	66	74	791
	{ Av. temp. (°C)	2.3	3.1	5.6	8.8	13.2	15.9	17.6	17.2	14.8	10.4	6.6	3.1	9.8
	{ Av. abs. annual temp. min. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—11.1
	{ Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	—4.1
Island of Jersey 49°11'North lat. Elev. 44 m	{ Precipitation (mm)	68	61	60	45	45	49	52	54	70	103	89	78	764
	{ Av. temp. (°C)	6.7	5.8	6.7	9.1	11.6	14.5	16.4	16.8	15.3	12.3	8.8	6.8	10.8
	{ Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—11.1
	{ Av. abs. annual temp. min. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—4.1
	{ Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	366

283

The climate of Aquitaine is distinguished by a higher temperature and mild winter, allowing winter barleys to be cultivated and corn to mature. For cotton, however, the warmth is insufficient. Humidity is adequate throughout the year but less so than in Bretagne. Summer is comparatively hot and dry. We note infection by stem rust. The potato and sugar beet grow well, but less so than in Bretagne and the vicinity of Paris. Oil-flax grows well, and peas and beans succeed. Instead of clover, lucerne is raised. The soils are here also podzolized but slightly oxidized. As above, the deciduous forest is the natural vegetation. The climate of Paris differs from that of Bretagne and Aquitaine by a somewhat higher aridity. Within the boundaries of the low-lying French north-western region, we may distinguish two agroecological areas:

46a. Northeastern France, including Belgium.

46b. Areas of Bretagne and adjacent areas of Aquitaine.

Tables 56 and 57 present the typical climatic data for these areas (see pages 276, 277).

284

The wheat flora types of France are to a considerable extent represented by hybrid forms (grown by the firm of Vilmorin) such as Bon Fermier, Universable, Vilmorin 23, Vilmorin 27, and similar forms. Selected types of barley and oats are produced by the same firm. Typical are long-fiber and intermediate-fiber forms of flax. Peas are represented by a considerable variety of selected forms of the European type.

The plant breeding firm of Vilmorin has been in existence over 200 years, and has had a very pronounced influence on the typical flora. Many types of hybrid origin constitute a special group. In the western areas, the region is characterized by late maturing oats, usually sown here in the autumn. Many are distinguished by great resistance to crown rust; many of them are dark-colored forms, such as Avoine, Grise, Bri, Houndon and others.

47. Northern Lowland German Agroecological Region

This includes the corresponding territories of the German Democratic Republic and the German Federal Republic.

The region is characterized by a harsher climate than in Northern France, but winter is still less severe than in the neighboring Baltic regions.

According to data from 1938, 20.5 million hectares were devoted in Germany to agricultural crops, or 43.7 % of the total area, of which 2.5 million hectares were under wheat. The leading cultivated area is found in the northern low-lying part of Germany.

We present typical climatic data for this agroecological region in Table 58.

Thanks to intensive selection, the German assortments of wheat, rye, barley and oats are exceptionally valuable. The majority of wheat types represents the result of hybridization with Squarehead. A large part of the area sown with rye in Germany is taken up by the Petcus rye, which is the basic standard for productivity, erectness and uniformity of grain.

Table 57

Climatic data of northwestern French low-lying agricultural region, including Belgium

Place	Temperature of warmest month	Temperature of coldest month	Abs. min. temp.	Annual precipitation	Days over +5°C	Av. abs. annual temp. min.
Bordeaux 44°50' North lat. Elev. 74 m	20.2	-4.8	-16.2	769	365	-
Chateauroux 46°49' North lat. Elev. 156 m	19.5	-3.0	-	-	259	-10.4
Lorient 47°45' North lat. Elev. 26 m	18.2	-5.9	-11.6	815	365	- 5.9
Brest 48°24' North lat. Elev. 50 m	17.7	-6.5	-11.0	821	365	- 4.3

285



Germany. Württemberg. Harvesting
of true spelt



Germany. Württemberg.
Spelt



Germany. Harvesting hybrids of true spelt with wheat



Germany. Harvesting hybrids of true spelt with wheat

The Laitevits type of oats, peculiar to foothill areas, is found and in addition Swedish selections types (the Probstier type) also exist in considerable amounts, such as Pobyeda (Victory), Zolotoi Dozht (Golden Rain) and Ligovo II; these rival the German types in yield. Barley is represented mainly by the beer-brewing two-rowed forms. Leguminous seed crops, widely cultivated, consist of the typical European hygrophilic, comparatively large-seed forms of peas and beans. For forage purposes, small-seed forms of peas of the Pelushka type are also widely grown. The cultivation of flax, which has decreased sharply in recent decades, is once more beginning to spread. Especially long-fiber forms of Russian flaxes are grown.

48. Baltic Agroecological Region, Including Northern Poland, Kaliningrad District of the RSFSR Lithuania, Latvia, Estonia, and Southern Central Part of Finland

The Baltic region, in contrast to the low-lying parts of Germany discussed above, is characterized by a comparatively harsh winter. The temperature quite often drops to -20° or lower. The climate is humid and rainfall varies from 500 to 650 mm. Climatic data for the region are presented in Table 59

Winter rye and cold-resistant types of winter wheat of the Sandomir type are widespread here. The types of wheat, rye, barley, oats and leguminous seed crops are distinguished by hygrophily and high productivity. Large amounts of long-fiber flax of high quality are grown. Dickkopf and Squarehead wheats are but rarely encountered. Winter wheat is represented chiefly by the awnless Sandomir type or a bearded red-grained Banat type.

The cereal types are characterized by great variety. Up to 20 types of winter wheat, both local and selected, have been given names. Petcus, Poolav, Dunkov Rogogolin, and other types of rye are grown. Considerable interest attaches to Zagnits rye, as one that has been judiciously selected over decades, on the fields of Zagnits (Berg). We distinguish dozens of types of winter wheats, such as High Lithuanian, Dankov, Pulav, Banat, and Sandomir types. Both awned and awnless forms are grown here. Farinaceous types of wheat distinguished by high yield are encountered in considerable quantities. The barleys are represented by two-rowed forms of the nutans and erectum varieties. Of the most widespread types we shall mention the Danubian Okerman, the Pulav beer-brewing type, Bedge XIII, Hanna, selected by the Heine Company, Olympia, Hildenbrandt, and more rarely, four-rowed forage barleys. Spring wheat is grown in comparatively small quantities but is also represented by a very large variety of types, such as Pulav, Kolben, Heine, Ordinat, the Edina bearded type and Khlopits. Oats are represented by universal types, for example, the Pobyeda (Victory) type grown by the Svalof station.

49. Maritime West European Agroecological Region, Including Lowland Great Britain and Ireland, Holland, Denmark, Southern Coastal Sweden, Narrow Strip of Southern Coastal Lowland Norway

The agricultural areas of the above countries are characterized by a relatively mild climate and long growth period, thanks to the moderating influence of the sea and the warm sea current. The summer is comparatively cool. In those areas with the most mild climatic conditions, growth is possible throughout the year without interruption.

Table 58

Climatic data of North Lowland German Agroecological Region

Place	Data	Month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Hanover 52°02' North lat. Elev. 55 m	Precipitation (mm)	43	41	52	40	52	69	82	68	47	48	42	45	629
	Av. temp. (°C)	0.3	1.3	3.7	7.7	12.7	16.0	17.2	16.4	13.5	9.1	4.5	1.6	8.7
	Precipitation (mm)	48	47	51	46	50	62	86	76	55	63	51	53	688
	Av. temp. (°C)	-0.3	0.8	3.1	7.3	12.0	15.6	16.9	16.1	13.6	8.8	4.1	1.3	8.9
Hamburg 53°33' North lat. Elev. 25 m	Av. abs. annual temp. min. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-12
	Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-18.4
	Precipitation (mm)	37	35	43	35	49	52	75	54	46	44	41	43	554
	Av. temp. (°C)	0.3	1.0	3.8	8.3	13.9	17.5	18.8	17.8	14.5	9.3	4.2	1.0	9.1
Berlin 52°33' North lat. Elev. 35 m	Av. abs. annual temp. min. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-13.8
	Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-28.1
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	233
	Precipitation (mm)	35	36	48	40	61	67	90	63	58	49	43	42	632
Leipzig 51°20' North lat. Elev. 120 m	Av. temp. (°C)	-0.9	0.6	3.4	8.0	13.3	16.9	18.1	17.3	13.7	8.9	3.7	0.7	8.6
	Av. abs. annual temp. min. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-15.6
	Precipitation (mm)	32	29	37	39	58	62	82	72	48	39	37	38	573
	Av. temp. (°C)	-1.3	-0.3	1.9	5.0	13.3	17.1	18.6	17.9	14.2	9.1	3.2	-0.2	8.5
Wroclaw, Poland 51°07' North lat. Elev. 147 m	Av. abs. annual temp. min. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-17.1
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	225

In climate the region is close to the north-west of France (Bretagne). Agriculture is intensive, applying a large amount of organic and mineral fertilizers and attaining a high level of agrotechnology. The yields here attain the maximum average values known anywhere in the world for barley and wheat.

Typical climatic data for the region are presented in Table 60.

289 The differences between spring and winter forms are pronounced. The developmental stages, both the temperature stages (vernalization) and the light stages, are extremely protracted in the typical winter types of the region. Thanks to selection and exceptionally favorable cultivation conditions, particularly productive types of barley, wheat, oats and leguminous seed crops have developed. Large-seeded forms predominate. By selection, types comparatively resistant to species of fungi causing infectious diseases have been bred in recent decades. A typical peculiarity of native and selected types of the region (Figures 139, 144) is their humidity needs. Under favorable conditions, they are distinguished by a large vegetative bulk and a large strong ear. In the 19th century, the Squarehead type of wheat became widespread and at the present time Squarehead forms are grown almost exclusively. Such a one, for instance, is the Dutch Wilhemina, a type developed by the geneticist Broken. In England, to this day, typical English wheat (*Triticum turgidum*), known by the name of "Rivet" is grown in considerable quantities (nearly 5% of entire area sown with wheat).

50. Scandinavian Agroecological Region, Including Regions of Inland Sweden, Norway, and Finland

290 In this agroecological region, we include the whole interior of Sweden, Norway, with the exception of the narrow southern coastal strip washed by the warm sea current, and a large part of the territory of Finland. As a whole the region is characterized, in comparison with the preceding region, by a short growing period, severe winter and low temperatures in spring and autumn, falling even lower as we proceed northwards. Rainfall averages vary from 500 to 550 mm, increasing sharply only in the far north, to reach 2,000 mm or more in Bergen.

On account of the mountainous nature of the Scandinavian peninsula, agriculture here occupies small areas, mainly in the coastal strip. In the past the entire territory was covered by forests.

291. We present below some climatic data for Sweden and Finland (Table 61).

The difference between spring and winter types of wheat and rye are more pronounced here than in any other region in the world. Winter wheat from Finland and the north of Sweden have the longest initial stages of development known, requiring vernalization for 60-75 days at low temperatures. The second stage (the light stage) is also protracted. In general, the types possess an average degree of winter resistance and under the conditions of the non-chernozem zone of the European part of the Soviet Union around Moscow and Leningrad, usually display poor resistance to winter. The spring varieties of the grains of the region are distinguished by rapid maturation even under comparatively low temperatures.

Table 59

Climatic data of the Baltic Agroecological Region

Place	Data	Month												Average
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Poznan 52°56' North lat. Elev. 58 m	Precipitation (mm)	28	37	34	37	61	46	77	46	41	27	36	34	504
	Av. temp. (°C)	-1.9	-1.0	2.0	7.7	12.9	17.2	18.8	17.9	14.0	8.6	2.6	-0.8	8.2
	Av. abs. annual temp. min. (°C)...	—	—	—	—	—	—	—	—	—	—	—	—	-17.1
Tartu 58°23' North lat. Elev. 75 m	Precipitation (mm)	33	30	25	30	40	62	78	79	48	42	40	38	545
	Av. temp. (°C)	-6.2	-6.5	-3.4	3.6	10.6	14.7	16.6	14.8	10.4	5.2	-0.4	-1.7	4.6
	Av. abs. annual temp. min. (°C)...	—	—	—	—	—	—	—	—	—	—	—	—	-25.3
Suwalki, Poland 54°06' North lat.	Precipitation (mm)	35	33	31	48	49	82	83	75	47	36	46	42	607
	Av. temp. (°C)	-5.5	-5.0	-1.3	5.4	12.0	16.2	18.2	16.7	12.3	6.6	0.4	-3.9	6.0
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	—
Kaunas, Lithuania 54°53' North lat.	Precipitation (mm)	24	21	34	64	74	94	94	66	64	49	34	23	641
	Av. temp. (°C)	-4.7	-3.8	-0.4	6.1	12.9	16.2	17.9	16.5	12.1	6.9	1.3	-2.9	6.5
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	—
Vilnius, Lithuania 54°41' North lat.	Precipitation (mm)	32	27	27	36	47	73	80	90	45	42	40	33	572
	Av. temp. (°C)	-5.4	-4.2	-0.7	5.8	12.8	16.3	18.1	16.5	12.1	6.5	0.7	-3.1	6.3
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	—
Riga, Latvia 57°00' North lat. Elev. 13 m	Precipitation (mm)	33	34	29	37	40	64	88	84	52	47	50	40	598
	Av. temp. (°C)	-4.3	-4.1	-1.3	4.9	11.4	15.5	17.6	16.0	11.8	6.7	1.3	-2.9	6.0
	Av. abs. annual temp. min. (°C)...	—	—	—	—	—	—	—	—	—	—	—	—	—
Helsinki, Finland 62°02' North lat. Elev. 10 m	Precipitation (mm)	45	37	35	36	45	46	57	74	64	26	63	51	619
	Av. temp. (°C)	-6.3	-6.6	-4.0	1.1	7.8	13.8	16.6	15.3	10.8	5.4	0.1	-3.9	4.2
	Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-23.9
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	29.6
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	172

Table 59
(continued)

Place	Data	Month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Tallinn, Estonia 59°26' N. lat. Elev. 43m	Precipitation (mm)	25	22	21	28	38	43	48	66	51	51	38	30	461
	Av. temp. (°C)	-5.0	-5.8	-3.0	2.6	8.4	13.1	16.4	15.0	11.0	5.6	0.8	-3.0	4.7
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-23
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-31
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	174



FIGURE 142. Sown
peas - *Pisum sativum*
L., England



FIGURE 141 European subspecies
of beans - *Vicia faba* ssp. *europaea*
f. *viridissima* (Alef Murat. Windsor
beans. England. Beans, natural
size.), seeds (X 2)



FIGURE 143 Pod and
seeds of the Victoria
Mandorf variety of
peas



FIGURE 144 Pod and
seeds of the Capital peas
widespread in cultivat-
ed areas of the USSR

Table 60

Climatic data of the littoral West European Agroecological Region

Place	Data	Month												Σ
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Gröningen, Holland 53°13' North lat. Elev. 10 m	Precipitation (mm)	48	42	44	39	45	60	71	84	66	68	60	55	680
	Av. temp. (°C)	1.2	1.9	4.0	7.5	11.8	14.9	16.3	16.0	13.5	9.1	5.0	2.7	8.6
	Av. abs. annual temp. min. (°C) ..	—	—	—	—	—	—	—	—	—	—	—	—	—11.8
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—18.8
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	230
Copenhagen 55°41' North lat. Elev. 5 m	Precipitation (mm)	34	34	36	37	41	50	64	69	51	60	50	47	573
	Av. temp. (°C)	—0.4	—0.2	0.5	5.8	11.0	15.4	17.0	16.0	12.7	8.2	4.0	1.3	7.7
	Av. abs.annual temp. min. (°C) ...	—	—	—	—	—	—	—	—	—	—	—	—	—13
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	213
Lund (Southern Sweden) 55°42' North lat. Elev. 38 m	Precipitation (mm)	43	37	39	40	38	51	71	75	53	59	55	53	614
	Av. temp. (°C)	—0.7	—0.7	1.2	5.3	10.4	14.5	16.5	15.5	12.4	7.9	3.4	0.5	7.2
	Av. abs. annual temp. min. (°C) ..	—	—	—	—	—	—	—	—	—	—	—	—	—16.1
Greenwich, near London 51°28' North lat. Elev. 45 m	Precipitation (mm)	42	43	43	39	43	52	56	55	46	63	58	56	595
	Av. temp. (°C)	3.7	4.3	5.7	8.5	11.9	15.1	17.1	16.7	14.2	10.0	6.7	4.7	9.9
	Av. abs. annual temp. min. (°C) ...	—	—	—	—	—	—	—	—	—	—	—	—	—7.2
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—15.6
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	284
Cambridge 52°12' North lat. Elev. 13 m	Precipitation (mm)	37	34	36	33	42	54	55	57	43	58	50	48	547
	Av. temp. (°C)	3.2	3.9	5.3	7.9	11.3	14.3	16.2	15.9	13.6	9.6	6.2	3.9	9.3
	Av. abs. annual temp. min. (°C) ..	—	—	—	—	—	—	—	—	—	—	—	—	—9.4
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—17.8
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	276

Table 6C
(continued)

Place	Data	Month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Oxford 51°46' North lat. Elev. 63 m	Precipitation (mm)	45	45	41	42	47	58	59	57	44	42	59	62	601
	Av. temp. (°C)	3.7	4.3	5.5	8.1	11.3	14.4	16.3	15.7	13.5	9.5	6.4	4.5	9.5
	Av. abs. annual temp. min. (°C) ...	—	—	—	—	—	—	—	—	—	—	—	—	—8.3
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	231
Utrecht, Holland 52°06' North lat.	Precipitation (mm)	50	44	45	38	47	57	75	80	69	72	59	63	699
	Av. temp. (°C)	1.2	2.0	4.0	8.0	11.8	15.6	17.1	16.7	14.0	9.4	4.7	2.1	8.9
	Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—11.4
	Av. abs. annual temp. min. (°C) ...	—	—	—	—	—	—	—	—	—	—	—	—	—20.7
Oslo 59°55' North lat. Elev. 25 m	Precipitation (mm)	30	25	26	28	42	55	85	79	78	64	49	91	586
	Av. temp. (°C)	—4.4	—4.5	—1.4	4.4	10.5	15.5	17.0	15.9	11.5	5.5	0.1	—3.6	5.5
	Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—29.5
	Av. abs. annual temp. min. (°C) ...	—	—	—	—	—	—	—	—	—	—	—	—	—19.0
Aberdeen, Scotland 57°10' North lat. Elev. 14 m	Precipitation (mm)	54	56	60	49	58	44	70	69	57	75	76	81	749
	Av. temp. (°C)	3.3	3.5	4.5	6.4	8.9	11.8	13.5	13.3	11.5	8.4	5.6	3.7	7.4
	Av. abs. annual temp. min. (°C) ...	—	—	—	—	—	—	—	—	—	—	—	—	—9.4
	Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—15.6
Edinburgh, Scotland 55°57' North lat. Elev. 76 m	Precipitation (mm)	52	46	42	39	17	60	69	75	64	61	59	58	672
	Av. temp. (°C)	3.4	3.7	4.4	7.0	9.6	12.8	14.1	14.1	11.9	8.3	5.4	3.9	8.2
	Av. abs. annual temp. min. (°C) ...	—	—	—	—	—	—	—	—	—	—	—	—	—7.7

Table 60
(continued)

Place	Data	Month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Dublin, Ireland 53°22' North lat. Elev. 47 m	Precipitation (mm)	57	48	48	47	52	51	67	79	60	66	73	64	702
	Av. temp. (°C)	4.6	4.8	5.3	7.1	9.6	12.7	14.4	13.9	12.0	8.9	6.5	5.0	8.7
	Av. abs. annual temp. min. (°C) ...	—	—	—	—	—	—	—	—	—	—	—	—	—8.9
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	365
York, England 53°57' North lat. Elev. 17 m	Precipitation (mm)	44	41	42	42	50	54	63	63	42	67	54	56	618
	Av. temp. (°C)	3.4	3.9	5.2	7.6	10.6	13.8	15.5	15.1	12.9	9.1	6.1	4.0	9.0
	Av. abs. annual temp. min. (°C) ...	—	—	—	—	—	—	—	—	—	—	—	—	—8.9
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	—
Arma, Ireland 54°21' North lat. Elev. 62 m	Precipitation (mm)	63	60	59	54	60	65	72	91	63	68	73	79	807
	Av. temp. (°C)	4.8	4.5	5.3	7.4	10.1	13.0	14.3	14.0	12.1	8.8	6.2	4.5	8.7
	Av. abs. annual temp. min. (°C) ...	—	—	—	—	—	—	—	—	—	—	—	—	—8.3
	Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—17.9
Glasgow, Scotland 55°53' North lat. Elev. 55 m	Precipitation (mm)	81	79	67	54	65	65	78	97	77	84	94	103	944
	Av. temp. (°C)	3.8	3.9	4.7	7.0	10.0	13.9	14.1	13.7	11.8	8.5	5.9	4.3	8.4
	Av. abs. annual temp. min. (°C) ...	—	—	—	—	—	—	—	—	—	—	—	—	—7.2
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	269

Table 61

Climatic data for the Scandinavian Agroecological Region

Place	Data	Month												Average
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Upsala, Sweden 59°51' North lat Elev. 24m	Precipitation (mm)	28	31	29	31	40	50	72	73	47	48	42	42	533
	Av. temp. (°C)	-4.1	-4.3	-2.2	3.1	8.8	14.0	16.5	14.6	10.5	5.1	0.1	-3.2	4.9
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	176
Stockholm 59°21' North lat. Elev. 44m	Precipitation (mm)	35	33	33	37	37	42	61	74	48	46	47	48	541
	Av. temp. (°C)	-2.9	-3.1	-1.3	3.4	8.8	14.1	16.8	15.2	11.4	6.2	1.5	-1.7	5.7
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-18.6
Oulu, Finland 65°01' North lat. Elev. 10m	Precipitation (mm)	39	31	27	30	35	45	63	74	58	62	43	39	536
	Av. temp. (°C)	-9.7	-10.7	-6.7	0.0	5.4	11.7	15.2	12.3	7.9	2.2	-3.1	-7.7	1.4
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-29.9
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-36.5
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	145

Table 62

Climatic data for Bergen, Norway, 60°23' North lat., Elev. 18 m

Data	Month												Average
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Precipitation (mm)	224	181	155	112	118	106	142	195	237	233	220	221	2144
Av. temp. (°C)	1.2	1.3	2.2	5.7	9.4	10.9	14.4	13.5	11.1	7.4	4.0	3.0	7.1
Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-15.1
Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	209

As the result of the exceptionally highly organized practice of selection in Sweden, very productive types of wheat, barley and oats have evolved, distinguished by highly desirable qualities. Among the Swedish and Norwegian barleys exist strong-straw forms. Black oats are grown in considerable quantities. Many of the Scandinavian forms, particularly the more northerly kinds, are of great interest for the northern areas of the Soviet Union because of their speed of maturation and the fact that they have no great demands for warmth nor do they germinate on the root or lie prone. Very large numbers of Scandinavian types of wheat are comparatively resistant to yellow rust. As a result of modern selection in Finland a series of valuable rapidly maturing forms of winter wheat has evolved.

The climatic contrasts of the far north of Norway, due to the influence of the sea current, may be judged from observations in Bergen (Table 62). Under such conditions, cereal cultivation becomes impossible and the sea areas are suitable only for pastures.

European Steppe Agroecological Region (in a broad sense)

The European steppes embrace a large territory, including the Hungarian plain, a large part of Yugoslavia, Northern Bulgaria and Southern Czechoslovakia, much of Southeastern Rumania, the steppe part of Poland, all Moldavia, the steppes of the Ukraine, the steppe-lands of the Crimea, the steppe-areas of the Northern Caucasus and the Volga area and the southern steppe parts of the Kursk and Voronezh regions.

The western border of the European steppe zone is formed by the Alps and Balkan Mountains. In the west, the European steppe commences in Hungary; in the east the natural border is the Ural chain and its spurs. This huge steppe zone is interrupted only by the Carpathians dividing the Hungarian steppe from the Great Valakhia steppe (lowlands).

On the south, the border of the European steppe is formed by the Balkans, the Black Sea and Caucasian range, and in Crimea by the Tails. To the north, the border is the forest steppes. In general this extensive steppe land coincides with the zone of chernozems (black soil).

The entire steppe zone is characterized by a continental climate, a limited amount of rain, hot summer and severe winter with very low temperatures, particularly in the East. In the past this was the domain of the steppes.

A definite order may be observed in the distribution of cultivated plants in the European steppes. In the west the climate is milder and winter less severe. Here the predominating culture is winter wheat, while in the south, corn is grown. In the eastern areas (Volga Region) and areas located east of the Don River, spring wheat is more cultivated. Cotton matures in the hottest areas in South Ukraine and Northern Caucasus. Recent years have seen some half a million hectares devoted to irrigated cultivation of cotton. In the dry areas of the steppe, corn suffers considerably from drought particularly if the period of flowering comes under the destructive action of dry winds. Instead of red clover, which cannot suffer drought, lucerne is grown here. Potatoes grow poorly. They produce small tubers and are subject to virus diseases (degeneration). In the less dry areas, oil-producing flax and sugar beet are grown successfully.

The European steppe zone may be sub-divided into five agroecological regions:

51. Hungarian steppe, including the bordering foothill areas, among them the Banat.
52. Danube steppe, including the lowlands of Rumania and Northern Bulgaria (the Great Walachian Plain) .
53. Steppe part of the Ukraine, including Moldavia and the steppes of the Crimea.
54. North Caucasian steppe region, including steppe areas of the Krasnodar-Stavropol territories and the Rostov region.
55. Volga steppe, including the region of Kuibishev, Saratov, Balashov, Stalingrad, the region south-east of Voronezh, the steppe areas of the Urals, and the southern part of Bashkiria.

51. Hungarian Steppe, Including Its Surrounding Foothill Regions, Among them Banat

This agroecological region is isolated from all sides: on the west its border are spurs of the Austrian Alps, on the south the Balkan Mountains, and on the north and east the Carpathian arc. The Hungarian steppe is traversed by the middle course of the Donau River and its important tributary, the Tisza. Administratively speaking the Hungarian steppe is part of the Hungarian Peoples Republic, takes a considerable part of the Federative Peoples Republic of Yugoslavia, the southern part of the Czechoslovakian Peoples Republic and the small north-eastern corner of Austria.

The climate of the Hungarian steppe is continental, characterized by strong winds and pronounced differences of winter and summer temperatures. The amount of rainfall varies from 500 to 600 mm in the eastern part beyond the Tisza River and reaches 800 mm west of the Danube. Wild grass vegetation flourishes particularly in the eastern dry part of the lowlands. The western part tends more to woods. The average elevation of the Hungarian steppe does not exceed 108 m above sea level. The soils are alluvial with a loess structure, and are fertile.

302

We present the climatic data for the Hungarian steppe in Table 63.

The Hungarian steppe is used principally to cultivate winter wheat, winter rye, barley, corn and oats. In recent years some one-half million hectares (1939) have been devoted to wheat. Fields sown with sugar beet are concentrated chiefly in the northwestern Trans-Danubian Region. In the Hungarian Plain, Hungarian vetch (Vicia pannonica Jacqu.) is widespread. Together with the typical winter forms of wheat, "two-handers", i. e., types that may be sown both in autumn and early spring, are grown occasionally. A special interest is afforded by wheats of the foothills. This (the Banat locality) was the original habitat of the famous hyaline Banat forms, which have recently been covering the steppes of the Ukraine. The name Banat derives from the word "Ban", which in Hungarian means "frontier region". At present the Banat is the name applied to the mountain areas of southern Hungary. The soils of the Banat are distinguished by high fertility.

52. Danubian Steppe, Including Lowland Rumania and Northern Bulgaria (The Great Walachian Plain)

The Great Walachian (Rumanian) Plain is located along the lower Danube River reaches and its tributary, the Pruth. This includes the southeastern part of Rumania and the north of Bulgaria.

Table 63

Climatic data for the Hungarian Steppe

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Budapest 47°30' North lat. Elev. 153 m	Precipitation (mm)	38	33	45	61	72	76	53	50	53	64	53	49	647
	Av. temp. (°C)	-2.3	-0.4	4.4	10.5	15.0	18.7	20.9	20.1	16.0	10.3	4.0	-1.0	9.6
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-14.5
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	238
Szeged, Hungary 46°15' North lat. Elev. 90 m	Precipitation (mm)	31	27	32	51	68	70	56	43	44	52	42	38	554
	Av. temp. (°C)	-2.7	1.0	4.5	11.3	16.5	19.5	22.2	21.0	16.7	11.5	4.5	0.9	10.6
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-17.7
Zagreb, Yugoslavia 45°49' North lat. Elev. 163 m	Precipitation (mm)	46	47	57	72	79	100	81	81	86	98	79	61	887
	Av. temp. (°C)	-0.1	2.1	6.7	11.5	16.3	19.3	21.6	20.7	16.9	11.7	5.7	1.6	11.2
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-13.2
Osijek, Yugoslavia 45°33' North lat. Elev. 92 m	Precipitation (mm)	34	30	40	62	77	78	62	58	55	61	50	43	653
	Av. temp. (°C)	-1.5	0.9	6.2	11.3	16.9	20.2	22.1	21.2	16.7	11.8	5.4	1.5	11.1
Corabia 43°46' North lat. Elev. 50 m	Precipitation (mm)	25	29	31	41	52	69	70	37	19	37	44	27	514
	Av. temp. (°C)	-2.7	0.5	5.8	11.3	17.0	20.9	22.9	22.3	17.7	11.8	4.7	0.7	11.1
Pleven, Bulgaria 43°27' North lat. Elev. 105 m	Precipitation (mm)	29	31	39	49	71	86	80	45	11	51	55	29	609
	Av. temp. (°C)	-1.2	0.5	6.1	11.7	17.0	20.6	22.8	22.0	17.1	11.6	4.9	0.7	11.2
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-21.0
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	251

This region is characterized by a hot summer and an amount of rainfall averaging 500-600 mm. The winters are severe.

Table 64 presents typical climatic data for the Danubian Steppe.

Rumania, like Italy, is distinguished by very intensive tilling of the soil. Of the 29.5 million hectares comprising the total territory of Rumania and Moldavia, 13.5 million have been reserved annually for cultivation in recent years. Of this area, wheat is grown on more than 3 million hectares. The assortment of winter wheats of Rumania is characterized by rapid maturation and fair resistance to winter conditions, inferior to that of the Crimean and Ukrainian types. As a result of the hot dry climate, comparatively drought-resistant forms of wheat have evolved. Considerable interest attaches to local oat types, some of which possess resistance to crown rust.

53. Steppe Ukraine, Including Moldavia and the Steppe Crimea

This region includes all steppe areas of the Ukraine, Moldavia, and the steppe section of Crimea. The central and eastern areas of this region are characterized by a dry climate, rain averaging 360 - 510 mm yearly. Maximum rainfall occurs in June-August. Summer is hot, the growth period prolonged and winters comparatively harsh, with very low temperatures and usually insufficient snowfall. During the severe winters partial destruction of winter wheat and even rye is often observed (Figure 145), the reasons being the low temperatures during the snowless winter and the abrupt temperature fluctuations (from thaws to freezing).

The destructive action of dry winds is often apparent. Typical climatic data for this region are presented in Table 65.



FIGURE 145 Cultivated rye—Secale cereale L., Petcus variety



FIGURE 146 Soft wheat—Triticum vulgare—Vill. Zarya variety

Table 64

Climatic data for the Danubian steppe

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Bucharest 44°25' North lat. Elev. 84 m	{ Precipitation (mm)	30	23	33	43	59	110	56	55	52	41	41	31	534
	{ Av. temp. (°C)	-3.4	-0.9	4.8	11.2	16.3	20.4	22.7	22.1	17.5	11.6	4.3	-0.6	10.6
	{ Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-19.6
	{ Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	242
Dorochoi, Rumania 47°59' North lat. Elev. 178 m	{ Precipitation (mm)	20	22	32	47	58	102	86	59	60	40	30	21	577
	{ Av. temp. (°C)	-4.2	-2.0	2.3	8.3	14.5	17.9	19.6	18.7	14.2	8.6	1.9	-1.5	8.2
	{ Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	220
Iasi, Rumania 47°10' North lat. Elev. 100 m	{ Precipitation (mm)	23	29	37	45	49	82	66	46	52	37	33	23	526
	{ Av. temp. (°C)	-3.3	-1.4	3.5	10.0	16.0	19.3	21.2	20.6	16.0	10.2	3.5	-0.7	9.6
	{ Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	232
Streihareti 44°26' North lat. Elev. 160 m	{ Precipitation (mm)	27	28	26	33	54	75	59	40	48	39	39	28	496
	{ Av. temp. (°C)	-3.4	-0.5	4.3	10.4	16.1	19.5	22.0	21.7	17.2	11.3	4.6	-0.1	10.4
	{ Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	244

Table 65

Climatic data for the steppes of the Ukraine, including Moldavia and the steppe section of Crimea

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Simferopol 44°57' North lat. Elev. 223 m	Precipitation (mm)	30	27	32	32	34	57	58	33	35	26	32	41	437
	Av. temp. (°C)	-1.3	-0.3	3.9	8.8	14.8	18.7	21.6	20.7	15.7	11.1	4.8	1.6	10.0
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-26.0
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-18.4
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	237
Kishinev 47°02' North lat. Elev. 113 m	Precipitation (mm)	24	24	31	38	48	61	64	39	34	35	31	25	454
	Av. temp. (°C)	-3.9	-1.8	2.6	9.0	15.8	19.1	21.4	20.4	15.6	10.0	3.4	-0.3	9.2
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-20.0
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-26.5
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	228
Kharkov 50°04' North lat. Elev. 140 m	Precipitation (mm)	32	25	34	34	44	71	70	53	31	41	38	34	507
	Av. temp. (°C)	-7.8	-6.1	-1.4	7.0	14.4	18.1	20.4	18.9	13.3	7.0	0.0	-4.9	6.6
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-36.9
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-28.7
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	201

Table 65
(continued)

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Poltava 49°35' North lat. Elev. 183m	Precipitation (mm)	21	20	32	29	36	70	66	52	24	40	32	29	451
	Av. temp. (°C)	-7.3	-5.8	-1.1	7.1	14.9	18.0	20.6	19.4	14.1	7.4	0.2	-4.5	6.9
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-31.4
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-25.5
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	202
Odessa 46°26' North lat. Elev. 43 m	Precipitation (mm)	28	25	27	23	27	55	40	32	25	36	24	27	369
	Av. temp. (°C)	-3.1	-1.7	2.0	7.6	14.4	18.7	21.4	21.0	16.3	11.2	4.6	0.1	9.4
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-19.3
	Min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-25.9
	Days with over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	226
Nikolaev 46°58' North lat. Elev. 20 m	Precipitation (mm)	24	29	27	26	38	75	43	27	21	32	22	24	388
	Av. temp. (°C)	-4.0	-2.3	2.4	9.1	16.4	20.1	23.1	22.1	16.7	10.5	3.5	-1.0	9.7
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-24.7
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	19.3
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	227

306

In the past, large amounts of spring wheat were grown on the Ukraine steppe. Today there is a marked preponderance of winter wheat fields. The most widespread standard type has recently been the Ukrainka type of Banat--a bearded red-grain soft wheat. In the more humid western areas, wheat is often attacked by brown and yellow rust, as a result of which immune types have recently been introduced into farming, for instance, Zaria (Dawn) from the Nemerchen Experimental Station, and others (Figures 146-147).

The Verkhniach Experimental Station has developed types of oats immune to crown rust from local types. The left bank areas of the Ukraine have winter-resistant types such as Hostianum 0237, grown by the Saratov Station and introduced to meet the severity of winter conditions. In the Crimea, bearded winter Krimka (Crimean) types are widespread, and these have been the source of the well-known American wheat known as "Turkish wheat". From Krimka (Crimean) individual selection was applied to develop the American "Blackhull" type, occupying several million hectares in Southern USA. In the east of the Ukraine steppe, hard wheats

307



FIGURE 147 Soft wheat--*Triticum vulgare* Vill., Triumph of Podolia variety



FIGURE 148 *Hordeum vulgare* L. var. *pallidum* Sér., pallidum variety 045

308 were also grown in the past, when more soils remained fallow, occupying a considerable area. In general, both winter and spring Ukraine steppe types are distinguished by swift maturation and comparative drought resistance. On the light soils winter rye grows in great profusion. Cultivation of forage barleys, oats and oil-producing flax is also widespread. The latter is represented chiefly by a medium-length fiber type.

54. The Northern Caucasus Steppe

This agroecological region consists of the steppe areas of the Northern Caucasus, including the administrative areas of the Krasnodar and Stavropol territories and the Rostov area.

The climatic data, which in general resemble those of the steppe region of the Ukraine, vary in the direction of greater dryness as we proceed from the Caucasian range northwards. A very small quantity of rainfall is peculiar to the steppe areas of the Main Caucasian Range foothills. The similarity to the steppe part of the Ukraine is attested to by the great quantities of wheats of the Ukrainian standard type Ukrainka recently raised here. The climatic data of the region are presented in Table 66.

In the southern and central areas of the North Caucasian Steppe Region, the chief crops are winter soft wheat, while in the north spring wheat predominates. To a considerable extent, these are represented by hard wheat called Kubanka and Gharnovka.

Large amounts of six-rowed and two-rowed barley are grown here. In the south, six-rowed winter barley is widespread, distinguished by high resistance to winter conditions. Lately, particularly in the foothills, where wheat suffers from rust, the Ukrainka type has begun to be supplanted by new winter wheat types developed by the Krasnodar and Stavropol Experimental Stations, such as Krasnodarka and Stavropol 622. The American types Illinois Chief and the hybrid Kanred Full-caster, immune to brown rust, also grow well here. Of the standard barley types, the winter type Pallidum 2494, the spring type Colchicum 10/30 and others grow successfully. In the northeastern part of the region, fields sown with hard wheat distinguished by high qualities are widespread. This is one of the important areas in the USSR for oil flax. Much wheat and rye are produced in the North. Much corn, whose sown areas increase as we proceed to the Caucasus foothills, is also grown. A principal North Caucasian steppe crop is the sunflower.

55. The Volga Steppe

The Volga Steppe Agro-ecological Region embraces areas mainly forming part of the Kuibyshev, Balashov and Stalingrad regions. This includes the southeastern part of the Voronezh region, the western part of the Cis-Ural area and Southern Bashkiria, the Eastern Ukraine steppe areas, such as the Dniepropetrovsk area and the area of the North Caucasian steppe near Stalingrad.

This steppe agroecological region of Europe is characterized by severe winter conditions as a consequence of the insufficiency of snow cover. As a result, winter wheat is being supplanted above all by spring wheats, largely represented by hard forms. Cereals here frequently suffer from drought. The agricultural areas of the Volga Steppe are characterized by a predominance of southeastern winds and the destructive action of dry winds and insufficient quantities of rain. Climatic data for the region are presented in Table 67.

Table 66

Climatic data of Northern Caucasus Steppe

Place	Data	Month												Σ
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Rostov-on-Don 47°13' North lat. Elev. 48 m	Precipitation (mm)	33	38	31	37	42	60	63	24	26	33	41	37	465
	Av. temp. (°C)	-6.1	-4.0	1.0	9.0	16.8	20.7	23.7	22.8	16.5	9.8	2.3	2.5	9.2
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-23.1
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-23.0
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	219
Krasnodar 45°02' North lat. Elev. 24 m	Precipitation (mm)	45	46	45	45	61	65	66	48	41	17	60	69	640
	Av. temp. (°C)	-2.1	-0.1	5.0	10.6	16.7	20.4	23.7	22.9	17.6	12.2	5.3	1.1	11.1
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-33.5
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-21.6
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	245
Stavropol 45°03' North lat. Elev. 575 m	Precipitation (mm)	32	29	34	57	74	103	42	43	59	37	54	44	648
	Av. temp. (°C)	-4.6	-3.0	1.3	6.9	13.5	17.6	20.6	20.0	14.6	9.1	2.6	-1.2	8.1
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-29.8
Tikhoretsk 45°51' North lat. Elev. 13 m	Precipitation (mm)	25	33	38	31	55	69	41	17	36	30	57	48	480
	Av. temp. (°C)	-4.9	-2.4	2.2	9.3	16.5	19.5	22.9	22.3	16.4	10.7	3.3	-1.4	9.5

Table 67

Climatic data for the Volga Steppe

Place	Data	Month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Kuibyshev* (Samara) 53°14' North lat. Elev. 136 m	Precipitation (mm)	80	22	18	25	47	45	47	44	37	50	44	46	455
	Av. temp. (°C)	-11.0	-12.2	-6.4	3.8	14.1	15.3	20.7	18.4	12.0	9.9	-4.1	-10.2	3.9
Saratov 51°22' North lat. Elev. 60 m	Precipitation (mm)	18	14	23	22	39	46	56	37	43	41	29	24	392
	Av. temp. (°C)	-10.8	-12.1	-5.2	5.9	14.4	14.7	21.1	19.5	13.6	5.6	-1.9	-9.4	4.9
	Days over +5°C	—	—	—	—	—	—	—	—	—	—	—	—	189
Kamyshin 50°05' North lat. Elev. 24 m	Precipitation (mm)	13	9	11	15	36	31	36	44	31	18	17	18	287
	Av. temp. (°C)	-10.8	-9.2	-3.9	6.7	16.2	21.0	24.0	21.8	15.0	6.8	-1.1	-7.1	6.6
	Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-37.2
Syzran 53°09' North lat. Elev. 39 m	Precipitation (mm)	23	19	16	17	25	50	36	32	34	36	23	27	346
	Av. temp. (°C)	-13.1	-11.5	-5.5	4.4	14.2	18.9	21.1	19.1	12.5	4.7	-3.0	-9.2	4.4
	Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-42.6
Stalingrad 48°42' North lat. Elev. 40 m	Precipitation (mm)	38	29	31	21	32	44	32	22	30	28	38	42	387
	Av. temp. (°C)	-9.9	-7.8	-2.4	7.8	17.0	21.7	21.7	22.9	16.0	8.0	0	-5.8	7.7
	Abs. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	-34.6
Chkalov 51°45' North lat. Elev. 114 m	Precipitation (mm)	34	24	21	21	39	44	31	35	26	29	42	38	387
	Av. temp. (°C)	-15.4	-13.5	-7.5	4.0	11.5	19.7	22.0	19.7	13.0	4.2	-1.6	-11.0	3.8

* Average data for seven years.

Table 67
(Continued)

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Kamennaia steppe (Voronezh region) 51°03' North lat. Elev. 188 m	Precipitation (mm)	18	18	16	21	46	59	60	60	39	37	34	26	482
	Av. temp. (°C)	-10.7	-9.1	-4.3	5.4	14.3	18.0	20.5	18.7	12.6	5.5	-1.8	-7.2	5.2
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-34.2
Bezenchuk 52°59' North lat. Elev. 47 m	Precipitation (mm)	17	11	21	22	37	42	41	45	40	36	30	21	363
	Av. temp. (°C)	-12.7	-13.6	-6.4	5.2	13.9	17.6	21.2	18.8	12.5	4.6	-2.8	-10.8	4.0
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-39.7
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-32.2
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	179

312

In contrast to the preceding steppe regions, the areas of the Volga steppe agro-ecological region are characterized as noted, by the predominance of spring wheat, with both soft and hard wheats being raised. The standard wheat types are *Lutescens* 062 a typical beardless spring wheat, the bearded steppe Rusak 0323, and Sarrubra, a hybrid of hard and soft wheats grown by the Saratov Experimental Station. Of the hard wheats, *Melyanopus* 069, grown by the Krasnokutsk Station, is particularly widespread. As a result of natural and artificial selection very drought-resistant forms of wheat have evolved. The winter wheats, such as *Lutescens* 0329 and *Hostianum* 0237, developed by the Saratov Station and raised in comparatively small quantities, are distinguished by exceptional resistance to winter conditions, constituting the highest standards for resistance to winter conditions in the steppe areas of slight snow fall. Of the barleys, the drought-resistant two-rowed types do especially well. These include *Medicum* 026 and *Persicum* 064, developed from Armenian upland local barley (Figure 148). Rye is represented principally by local ameliorated population grown under the name of *Elisevskiya* (*Elysee*) (Figure 149). Oil flax of the medium fiber type is grown in considerable quantities. Of the other oleogenous crops, the Sunflower 169, selected by the Saratov Station (E.M. Plachek) is also widespread.

313

Of the leguminous seed crops, lentils grow successfully, tending in geographical distribution to the most humid areas. They are represented principally by a large platelike seed form, undoubtedly originating in the Mediterranean area. In the driest areas chick peas grow successfully. The Volga steppe region grain is characterized by specially high quality as a result of the accumulation of a large amount of protein.

The Forest Steppe Agroecological Region of East Europe (in the broad geographical sense)

The Forest Steppe Region of Eastern Europe stretches over a narrow band from Poland to the Ukraine, including South Poland, Czechoslovakia, the north-western forest-steppe section of the Ukraine, the northern section of the Kursk area, Northern Voronezh area, Rambov and Penza areas, the right bank of the Kuibyshev region, the north of Bashkirya and Tataria.

This zone may be divided into two agroecological regions according to the predominance of the chief crops.

56. Western forest-steppe region, including the forest steppe areas of Poland, Czechoslovakia, Austria, forest-steppe areas of the Ukraine, forest-steppe areas of the Kursk region, the northern section of the Voronezh area, and the southern sections of the Riazan area.
57. Eastern-forest-steppe region of European U.S.S.R. including the Tambov, Gorki and Penza areas, the right bank of the Kuibishev and Ulianov areas, Tataria and Northern Bashkiria. This region is characterized by a predominance of spring crops over winter ones.

56. Western Forest Steppe Region

The standard types of winter wheat for the west Ukrainian forest-steppe are Ukrainka, Zaria (Dawn) and Kharkov Station types, such as *Ferrigineum* 01239 and others.

Of the barleys, Hanna Loosdorf, European 0353/133, and *Colchicum* 010/30, are grown with success, i.e., two-rowed forms of the nutans variety. Of the oats,

Verkhnyach 053 and Lokhov grow particularly well. Rye is represented by the so-called regenerated Petcus rye. Broad areas are under sugar beet and forage grasses. In the Kursk and Voronezh regions, as a result of the colder winter, winter wheat types of Saratov selections grow more successfully, including Gostianum 0237 and Lutiscens 01060/10.

- 314 In the forest-steppe areas of Poland and Czechoslovakia, characterized by adequate quantities of rain, important agricultural concentrations, including wheats of the Banat type, are found.

Table 68 presents climatic data for this agroecological region.

In connection with the diversity of the relief, the forest-steppe areas of Poland and Czechoslovakia differ in annual rainfall, which varies from 450 to 700 mm. Here farming centers are found to be devoted chiefly to the cultivation of winter wheat, beer-brewing barley, and oats. Spring wheat and rye grow in smaller quantities. The winter wheat flora is particularly diverse. In addition to universal types spread all over Poland, the following types are also grown: Antoninska, Wczesna, Eka, Dankowska, Graniatka, Dankowska selekcyjna, Ostka skomereska, Pulawska, Wczesna, Sobieszczynska, Zlota, Maczuga, Hors Concours, Krakowianka, Ostka Grodkewicka, Podolanka, Superelecta, Wysokolitowka, Antoniska, Zaborzanka, Ostka Zopuska, Ependynka, Nadwislanka, Litwinka*.

Spring wheats, include the universal types, Ostka chlopiecka, Ostka Hildebrand, Ordynatka, Jedyna, Ostka Suska, Ostka Pulawska, Ostka Zopuska, Kolben Heine, Kalinowiecka, and Pulawska Twarda.

Oats are also represented by a large assortment of universal types, Bialy Mazur, Bialy Orzel, Antoninska Zlcolta, Sobieszczynska, Antoninska Biala, Bialy Udyecz, Teodozia goldregen Svalöf, Gelbhafer von Lochow, and special types peculiar to the south, such as Niemierczanski, Tatrzański, Zieleniak, Grzywacz.

Barleys are represented mainly by two-rowed forms, Hanna Skrzyszewicka, Danubia, Isaria Ackermana, Pulawski Browarny, Gullkorn Svalof, Hadostreng, Bethge XIII, Hanna Heine. Four-rowed forms also occur, such as Heine, Wanda, Dluzewski, Nordland, Sobieszczynski.

A large variety of selected and local rye types characterizes Poland. In the standards for the last years, approximately fifteen types of rye are listed, such as Dankowskie, Granum, Mikuliczy, Wczesna, Ottawzenskie, Zyliczia, Petcus v. Lochov, Pulawska Wczesna, Putsa, Rogalinskie, Wiezbienskie, Zeelandskie, Kazimiewskie, Sobieszczynskie, Wteszanowskie** (Figure 150).

The absence of strict governmental standardization produces a large number of types ecologically very similar and hardly distinguishable in yield and quality, supplied by various farms, experimental stations, and seed concerns.

57. Eastern Forest Steppe Region of European Part of the USSR

This region is characterized by not completely favorable conditions for wintering of wheats and by the periodical appearance of drought. Fields sown with winter rye (Figure 151) and oats (Figures 152-153) predominate among the grain cereals; peas (Figure 154) are sown in smaller quantities. To the east, a distinct

* Today many of the types enumerated here have been replaced by new ones. - [Russian editor's note].

** We present the names of Polish cereal types according to data obligingly supplied to us by Dr. Kostetskiĭ.



FIGURE 149. Cultivated rye - Secale cereale L., Elyseev variety

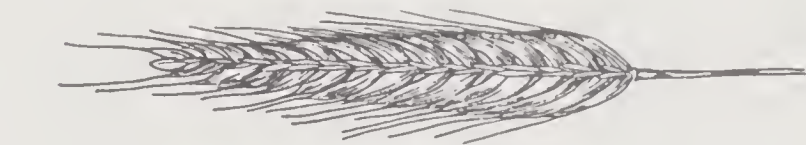


FIGURE 150. Cultivated rye - Secale cereale L., Verzhbin variety, Poland



FIGURE 151. Cultivated rye - Secale cereale L., Vyatka variety



FIGURE 152. Sown oats - Avena sativa L., Leitevits variety



Table 68.
Climatic data for western forest steppe Agroecological Region

Place	Data	Month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Brno (Czechoslovakia) 49°12' North lat. Elev. 205 m	Precipitation (mm)	25	24	31	36	57	69	68	65	39	40	36	30	520
	Av. temp. (°C)	-2.6	-1.0	2.9	9.7	13.6	17.3	19.1	18.3	14.5	9.2	2.9	-1.7	8.6
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-16.9
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	225
Krakow Poland 50°04' North lat. Elev. 220 m	Precipitation (mm)	27	32	37	45	68	109	127	94	60	51	37	33	720
	Av. temp. (°C)	-3.3	-2.0	2.0	7.9	13.3	17.0	18.7	17.7	13.0	9.8	2.2	-2.2	7.8
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-19.9
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	217
L'vov 49°50' North lat. Elev. 308 m	Precipitation (mm)	31	35	35	46	64	107	105	72	54	52	41	39	680
	Av. temp. (°C)	-4.0	-2.6	1.3	7.6	13.4	17.1	18.7	17.9	13.8	8.7	2.3	-2.3	7.6
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-20.4
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	215
Tiraspol 46°45' North lat. Elev. 319 m	Precipitation (mm)	26	20	26	43	59	89	89	61	42	47	34	23	559
	Av. temp. (°C)	-5.9	-4.7	-0.3	6.5	13.1	16.8	18.4	17.5	13.0	7.6	1.0	-3.6	6.6
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-24.3
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	202
Kiev 50°27' North lat. Elev. 183 m	Precipitation (mm)	35	30	44	44	51	74	81	56	46	49	41	39	590
	Av. temp. (°C)	-8.0	-4.7	-0.5	6.8	14.6	17.4	19.3	18.2	13.4	7.3	0.7	-3.5	6.7
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-23.9
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-30.0
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	203

317
318

Table 68
(Continued)

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Zhitomir 50°15' North lat. Elev. 223m	Precipitation (mm)	26	21	30	38	67	68	88	59	40	51	40	32	560
	Av. temp. (°C)	-5.6	-4.2	-0.1	6.6	13.9	17.0	18.9	17.5	12.9	7.2	0.9	-3.0	6.8
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-13.9
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-32.8
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	208
Nemerchi 48°40' North lat.	Precipitation (mm)	21	22	34	46	67	81	72	49	54	58	46	32	582
	Av. temp. (°C)	-5.4	-3.6	0.8	7.2	14.2	17.1	19.2	18.2	13.7	7.8	1.4	-2.4	7.4
Vinnitsa 49°15' North lat.	Precipitation (mm)	21	19	23	32	48	65	83	58	38	42	41	31	501
	Av. temp. (°C)	-6.2	-4.7	-0.5	6.3	13.8	16.8	18.8	17.8	13.3	7.0	0.6	-3.5	6.6
Sumy 50°52' North lat.	Precipitation (mm)	18	28	20	30	34	68	73	48	35	46	24	26	450
	Av. temp. (°C)	-3.3	-6.7	-2.1	6.2	14.1	17.6	19.7	18.4	12.9	6.6	-0.6	-5.2	6.0
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-33.4
Kursk 51°45' North lat. Elev. 236 m	Precipitation (mm)	36	31	41	36	49	57	68	63	37	48	38	42	546
	Av. temp. (°C)	-9.3	-7.8	-3.0	5.6	13.8	17.6	20.0	18.6	12.6	6.1	-1.3	-6.3	5.6
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-30.5
Shatilovo	Precipitation (mm)	31	31	23	37	47	78	79	62	41	44	37	38	548
	Av. temp. (°C)	-10.8	-2.5	-4.9	3.4	12.6	16.2	18.5	16.9	10.0	4.4	-2.6	-7.5	4.5
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	32.8
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	177

- 319 predominance of spring crops over winter crops sets in. A particularly unfavorable factor for the development of wheat and barley farming is the wide distribution of Swedish fly. A typical peculiarity of the forest-steppes are the wide fluctuations of temperatures in the spring, delaying the development of the plants. The climatic data for this agroecological region are presented in Table 69.

The standard types of spring wheat in the eastern forest-steppe are Tesczium 0111, Lutescens 062 and the hard wheats Hordeiforme 0189 and Hordeiforme 0432. Barleys are represented here to a considerable extent by the Viner two-row type; of the oil-bearing plants, the sunflower (Figure 155), flax and hemp grow successfully.



FIGURE 153. Sown oats—Avena sativa L., Stepnyak variety.

The forest-steppe within the borders of the European part of the USSR is commonly divided into a northern and a southern region. In the north, we usually include what is essentially a sub-zone of deciduous forests, with grey forest soils and podzolized and leached chernozems. At the present time most of the forests have been chopped down and in their place agricultural areas established, while the forests (oak and birch) are represented by small concentrations. The southern forest-steppe consists of a sub-zone of meadow-steppes with islands of deciduous forests, also partially destroyed. The soils in the southern forest-steppes are rich and normal chernozems. Grey forests and podzolized chernozems have taken the place of the disappearing forests. On the whole, the eastern part of the forest-steppe is particularly favorable for the growth of rye, oats, potatoes, hemp and clover. Spring wheat tends to the more easterly areas.

Table 69
Climatic data for the eastern forest-steppe region of the European part of the USSR

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Voronezh 51°40' North lat. Elev. 122 m	{ Precipitation (mm)	35	25	32	35	47	58	51	29	34	37	35	480	
	{ Av. temp. (°C)	-9.7	-8.3	-3.6	5.8	14.6	18.4	18.7	12.6	5.7	-1.3	-6.6	5.6	
	{ Abs. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-36.5	
	{ Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	178	
Tambov 52°44' North lat. Elev. 130 m	{ Precipitation (mm)	38	35	27	33	53	57	51	42	45	39	40	509	
	{ Av. temp. (°C)	-11.1	-9.5	-4.6	4.9	14.0	17.8	18.0	11.7	5.0	-2.3	-7.7	4.7	
Ryazan' 54°38' North lat. Elev. 109 m	{ Precipitation (mm)	23	39	34	29	39	54	62	35	39	42	12	493	
	{ Av. temp. (°C)	-10.9	-9.4	-4.9	4.2	13.4	17.4	17.5	11.4	4.6	-2.1	-7.8	4.4	

Table 70

Climatic data for the forest region of Poland

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Bialystok 53°08' North lat. Elev. 186 m	Precipitation (mm)	27	33	25	43	52	83	86	72	42	32	38	36	579
	Av. temp. (°C)	-4.6	-4.0	-0.2	6.5	12.8	17.4	18.6	17.4	13.0	7.2	1.0	-3.2	6.8
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	204
Warsaw 52°13' North lat. Elev. 121 m	Precipitation (mm)	33	28	32	41	49	64	77	62	42	31	37	35	531
	Av. temp. (°C)	-3.6	-2.5	1.1	7.6	13.4	17.7	18.9	17.9	13.8	8.0	1.8	-2.3	7.6
	Av. abs. annual temp. min. (°C) ..	-	-	-	-	-	-	-	-	-	-	-	-	-19.8
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	21



FIGURE 154. Sown peas —
Pisum sativum L.,
Voronezh region

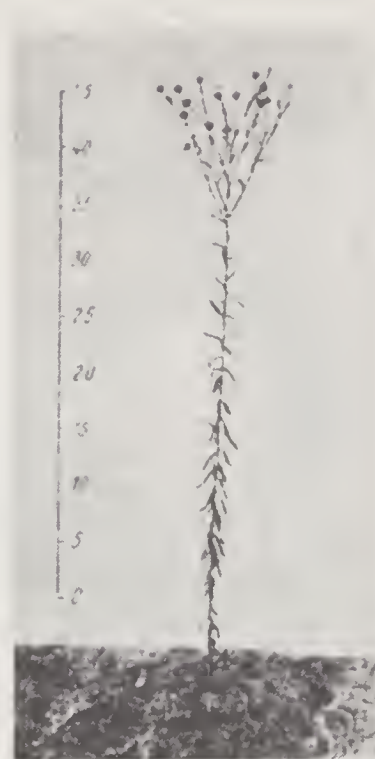


FIGURE 155. Flax—Linum
usitatissimum L., inter-
mediate fiber flax, Voronezh
region

321

Forest Region of Eastern Europe (in the broad geographical sense)

Large areas of north-eastern Europe, beginning from Poland, are constituted by former forest concentrations stretching to the Urals, and more or less brought under the plow in recent decades. The southern part of the forest zone is made up by both coniferous and deciduous forests, while the northern part consists solely of coniferous forests. The vast forest country of Eastern Europe may in turn be subdivided according to the degree to which it is plowed up and its climatological data into three agroecological regions.

58. Forest region of Poland.
59. Western non-chernozem region of the European part of the USSR.
60. Eastern non-chernozem region of the European part of the USSR.

58. Forest Region of Poland

A large part of the territory of Poland belongs to the forest zone and large areas of plowed lands in Northern Poland were occupied by forests in the not distant past. In contrast to the southern forest-steppe and steppe areas, where mainly wheat grows, the north-eastern areas of Poland are mainly a rye domain. Large quantities of barley, oats and potatoes are also grown. In the north-east are concentrated mainly fields sown with spinning flax.

This entire huge region is characterized by relatively plentiful quantities of rainfall, increasing as we proceed westwards. Winter is severe. Thanks to the considerable snow cover, wintering of winter crops takes place under favorable conditions. Winter wheats are represented principally by selected types, replacing the old local types. In soil and climatic conditions, the forest region of Poland is similar to the Baltic agroecological region, and the kinds of types of both these regions have much in common. In comparison to the Baltic area, Poland is characterized by a harsher continental climate. In spring, wheats and other crops sometimes suffer from drought. Summer, on the contrary, is distinguished as a rule by excessive humidity, and we therefore observe here the germination of grain on the stalk. Autumn is often dry. Winter temperatures fall to -29°C (Warsaw). The climate of the region may be grasped from the data (Table 70) only for two points which are in our possession.

While in the southern forest-steppe areas of Poland the chief types are those of winter wheat of the Banatka type, in the north are concentrated chiefly awnless wheats. In recent decades Swedish selected types characterized by their freedom from proneness and their high productivity, but insufficient resistance to winter conditions, have begun to penetrate.

The predominant crops of the forest region are winter rye, winter wheat, barley, oats and potatoes. Spring wheat is also encountered. The assortment of cereal types in Poland is very extensive from the point of view of nomenclature, although as pointed out, these varieties are on the whole ecologically hardly distinguishable.

Rye is represented chiefly by common types, such as Dankowskie, Granum, Mikuliczy wczesna, Ottawzenske, Syliczia, Petcus v. Lochow, Pulawskie wczesna, Putsa, Rogalinskie, Wierzbienskie, Zeelandzkie, Kazimiewskie, Sobieszczyńskie, Wteszanowskie.

The winter wheat of the forest region also contains comparatively common types spread all over Poland. We encounter with special frequency the types Antoninska wczesna, Eka, Dankowska, Graniatka, Dankowska Selekecyjna, Ostka skomereska, Pulawska wczesna, Wysokolitowka, Sobieszczyńska, Złota and Maczuga. A more limited area is characterized by Banatka kresowa, Uduscanzanka Biała, Złotka.

Oats are also represented by comparatively universal types, covering an extensive territory. These are Biały Mazur, Biały Orzeł, Antoninski żółty, Sobieszczyński, Antoninski Biały, Biały Udyć, Teodozia, Goldregen Svalöf, Ligowo III, Svalöf and Gelbhafer v. Lochow types.

In the Northeast are concentrated the so-called Rychlik Trybanski and Rychlik Kozarowski.

The bulk of the barleys is composed of two-row beer-brewing types: Hanna skrzyszewicka, Danubia, Isaria Ackermana, Pulawski Browarny, Gullkörn Svalöf, Hadostreng Bethge XIII, Hanna Heine.

Considerable quantities of four-rowed barley are also grown, such as Heine, Wanda, Dłuzewski, Nordland and Sobieszczyński.

Of the spring wheats, we note the most widespread Ostka Chłopiecka, Ostka Hildebranda, Ordynatka, Jedyna 330, Hildebrand, Ostka suska, Ostka Pulawska, Ostka Lopuska, Kolben Heine and Kalinowskiecka.

In the forest region of Poland, we may ecologically differentiate the more humid western section bordering on the German Democratic Republic, the less humid central and humid north eastern Baltic part, and the southern arid section adjacent to the forest-steppe.

59. Western Non-Chernozem Region of European Part of the USSR

The western non-chernozem region of the European USSR embraces a territory including Western Byelorussia, Velikoluki, Pskov, Novgorod, Kalinin and Leningrad regions, the region north of Moscow, the Ivanov and Yaroslavl region, and the region southwest of Vologda. In the north of this extensive ecological region coniferous forests are most widespread.

In the South and Southwest are mixed deciduous forests on podzolized soils. The northern boundary may arbitrarily be taken to be 62° latitude north.

The northern non-chernozem region is characterized by adequate and even excessive humidity, heavy snowfalls and maximum rains occurring in July and August. The most important property for cereal cultivation, particularly wheat, is drainage and fertilization. The climate is equable, particularly in summer. The greatest variations as regards both temperature and rainfall occur chiefly in spring and autumn. Winter conditions, particularly as concerns rye, including a large amount of snow, are comparatively favorable, particularly in the West. The growth period is comparatively short. There are frequent spring frosts, as well as a fall of temperature during the maturation period.

Climatic data for the western non-chernozem agroecological region are presented in Table 71).

In crop flora, the western non-chernozem agroecological region is characterized chiefly by widespread winter rye, oats, clover, flax, barley (Figures 156-157), and potatoes.

In the last decade, fields devoted to both winter and spring wheat have been extended considerably. On the whole, however, this agroecological region is characterized by a pronounced predominance of winter rye.

The intra-zonal existence here of large stretches of sandy loam and light sandy soil introduces a corresponding change in the crop flora. We must note sideration crops: lupine, seradella. Winter rye is mainly represented by the Vyatka type as well as local varieties, Swedish selection oats, such as Zolotoi dozd' (Golden Rain), Pobeda (Victory), and Moskovskii A-3105, which is grown from Western European local types, grow well here. The standard types of barley are taken to be the two-rowed beer-brewing barleys; Viner, Zolotoi (Golden) and Colchicum; the later is resistant to the Swedish fly. The standards for spring wheat here are Novinka, Garnet, and types grown from the Canadian Huron type. The standard winter wheat is Durable, grown by the Ivanov Experimental Station in the Kharkov region, and Ferrugineum 02411 and Ferrugineum 02453 of the Moscow station. Here are concentrated the best local and selected long-fibre flaxes. (Figures 8 and 158), whose origin dates back from time immemorial.

Table 71

Climatic data for the western non chernozem Agroecological Region of the European part of the USSR

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Ivanovo 57°01' North lat. Elev. 130 m	{ Precipitation (mm)	32	34	29	38	48	60	67	69	68	57	46	36	579
	{ Av. temp. (°C)	-12.0	-9.9	-5.0	3.4	11.9	15.8	18.8	16.0	9.9	3.3	-3.6	-9.1	3.3
	{ Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-41.7
	{ Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	171
Minsk 53°54' North lat. Elev. 225 m	{ Precipitation (mm)	37	36	34	41	51	82	87	76	45	42	41	39	611
	{ Av. temp. (°C)	-6.8	-5.8	-2.1	4.9	12.3	15.9	17.5	15.9	11.3	5.4	-0.5	-4.5	5.3
	{ Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-27.4
	{ Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-40.2
Novozybkov 52°32' North lat. Elev. 170 m	{ Precipitation (mm)	30	25	26	37	48	63	84	68	48	45	37	32	533
	{ Av. temp. (°C)	-7.8	-6.7	-2.5	5.4	13.4	16.6	18.5	17.0	11.9	5.7	-0.6	-6.1	5.6
	{ Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-83.5
	{ Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	186
Moscow 55°05' North lat. Elev. 167 m	{ Precipitation (mm)	37	34	35	41	50	66	80	78	55	60	44	38	613
	{ Av. temp. (°C)	-10.6	-9.1	-4.8	3.4	11.8	15.6	18.0	16.8	10.1	3.7	-2.8	-8.0	3.6
	{ Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-33.7
	{ Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-40.8
	{ Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	178

Table 71
(Continued)

Place	Data	Month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Velikie Luki 56°21' North lat. Elev. 104 m	Precipitation (mm)	28	25	25	28	46	71	85	81	47	41	34	32	649
	Av. temp. (°C)	-7.7	-6.8	-2.9	4.5	12.0	15.8	17.7	15.7	10.7	4.9	-1.0	-5.4	4.8
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-30.3
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-36.0
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	183
Leningrad 59°56' North lat. Elev. 6 m	Precipitation (mm)	28	24	24	33	40	55	48	84	58	48	37	33	512
	Av. temp. (°C)	-7.6	-6.7	-4.1	2.8	9.5	14.6	17.5	15.5	10.6	4.7	-0.9	-5.6	4.1
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-25.7
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	34.6
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	174
Vologda 59°14' North lat. Elev. 122 m	Precipitation (mm)	32	27	30	34	56	68	74	77	65	47	36	33	579
	Av. temp. (°C)	-12.0	-10.3	-5.9	2.1	10.3	14.8	17.6	14.7	9.1	2.5	-4.2	-9.5	2.4
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-34.9
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-41
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	162

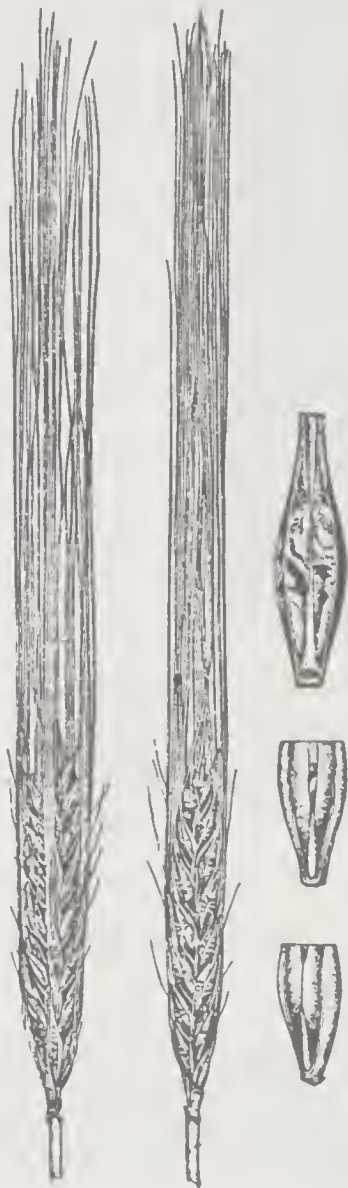


FIGURE 156. Barley - Hordeum vulgare L. var. pallidum, Ser. Arkhangel'sk region



FIGURE 157. Barley - Hordeum vulgare L. var. erectum 865/3. Pushkin Experimental Station of the All-Union Institute of Plant Breeding

There is no doubt that as long ago as the first century of our era splendid long-fiber flaxes grew in the areas around Pskov and Novgorod, the fibers from which were exported southward. Of the leguminous seed crops, the small seed pea of the Pelyushka type and large seed West European types (Figure 159), grow successfully. The West European types include Kapital, Irlandets and Viktoriya. In this region, horse-beans (Figure 160) may also grow. Of the flaxes, selected types of long fiber, such as Pobeditel (Victor), Tekstil'shchik (Textile worker) and Pioneer, of the Pskov Experimental Station, and DS-30 and DS-33, grown by the All-Union Institute of Plant Breeding*, have become particularly widespread in recent years.

The conditions of the western non-chernozem region are particularly favorable for the growth of potatoes. It is the most important potato cultivating area in the USSR.

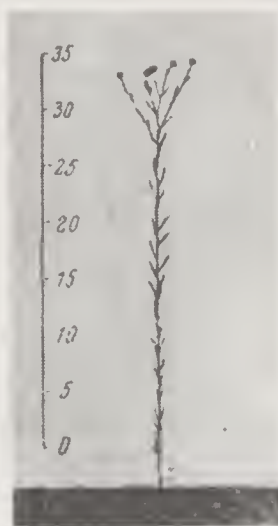


FIGURE 158. Flax - Linum usitatissimum L., type of low long-fiber flax, Arkhangel'sk region.

60. Eastern Non-Chernozem Region of the European Part of the USSR

The eastern non-chernozem agroecological region of the European part of the Soviet Union includes the region North of Gorki, the Kirov region, northeastern part of the Vologda region, the Komi ASSR, the Udmurt ASSR, a large part of the Sverdlovsk region, and the western part of the Omsk region up to the Ural Range.

329

On the whole, this large region is characterized by podzolized soils, a continental climate, sharp variations of temperature, rainfall of 400-600 mm yearly, sharp winter conditions and short growth periods. The climatic data for the region is presented in Table 72.

As in the preceding region, the soils here consist mainly of podzolized varieties. The natural vegetation in the North is coniferous forests and in the south mixed forests. The most widespread crops are winter rye, barley, clover and potatoes. The lentil (Figure 161) occupies considerably smaller areas. Spring and winter wheats are today the same as in the western non-chernozem region, but there will probably be others in the immediate future, as selection stations are at present

* N.I. Vavilov, Plant Breeding in the Leningrad Region and Methods for its Development. 1937 .



FIGURE 159. Variety of pea Zhegalova, G-112 type, on the lands of the All-Union Institute of Plant Breeding, Moscow Region



FIGURE 160. Northern subspecies of beans *Vicia faba* L., ssp. septentrionalis f. janthina Murat., Black Russian beans, Pods natural size, seeds X 2

Table 72

Climatic data for the Eastern non-chernozem agroecological region of the European part of the USSR

Place	Data	Month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Kostroma 57°46' North lat. Elev. 117 m	Precipitation (mm)	30	28	25	29	42	59	65	76	54	48	36	38	529
	Av. temp. (°C)	-12.3	-10.2	-5.5	2.8	11.5	15.4	18.2	15.5	9.6	3.1	-4.0	-9.3	2.9
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-33.6
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-40.9
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	169
Sverdlovsk 56°50' North lat. Elev. 281 m	Precipitation (mm)	17	12	12	22	48	65	74	69	36	29	28	27	439
	Av. temp. (°C)	-16.4	-13.1	-7.4	1.6	9.9	14.8	17.2	14.6	8.8	0.4	-7.8	-13.5	0.8
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-36.0
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-42.4
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	156
Molotov (Perm) 58°01' North lat. Elev. 163 m	Precipitation (mm)	40	33	31	27	51	66	68	74	59	47	56	48	600
	Av. temp. (°C)	-16.0	-12.8	-7.0	1.8	10.0	15.1	18.0	15.1	9.0	1.0	-7.4	-13.1	1.2
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-37.1
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-43.8
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	158
Kirov (Vyatka) 58°36' North lat. Elev. 181 m	Precipitation (mm)	38	32	26	27	49	63	62	71	58	52	45	37	560
	Av. temp. (°C)	-15.1	-12.3	-7.0	1.6	9.9	14.9	18.1	14.9	8.6	1.1	-6.8	-12.3	1.3
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-29.8
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-39.0
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	156

331 working on this. Of spring wheats, the Cseziium 0111 type is particularly widespread, and of winter wheats, the durable. Considerable interest is afforded by the local types of spring and winter wheat. In general, the winter wheat types of this region are characterized by a long vernalization stage and a comparatively prolonged second stage (light) and under conditions of this region are distinguished by rapid maturation.



FIGURE 161. Lentil - small seed and fodder - Lens esculenta Moench ssp. microsperma (Baumg.) Bar. var. vulgaris (Al.) Bar. from Molotov region

Siberia

The Western part of Siberia extends over huge stretches and we look at it from the point of view of reclaimed agricultural land. Agroecologically Siberia may be subdivided into four regions:

61. Western Siberian Steppe Region.
62. Western Siberian Forest-Steppe Region.
63. Western Siberian Taiga Region.
64. Altaï Sayan Agricultural Region.

61. West-Siberian steppe region

This agroecological region includes northern steppe areas, particularly south of the Trans-Siberian Railway, along the Chelyabinsk Petropavlovsk-Omsk-Novosibirsk line, comprising the steppe areas of Northern Kazakhstan. The natural vegetation here consists of steppe meadows growing various grasses, and grassy cereal steppes with various crops.

During the past decade a maximal expansion of farm land has been observed here and important new plow lands are planned in the immediate year. This agro-ecological region is characterized by a predominance of spring sowing, which results from the severe winters with little snow typical of these steppe areas. In this respect, the Western Siberia steppe areas resemble Canada with its predominating spring wheat agriculture. The growth period is comparatively short - about 120-130 days. On the whole the region is characterized by a continental dry climate, particularly as we proceed to the Urals.

We present typical climatic data in Table 73.

In the spring, droughts usually appear, and this accords particularly well with the presence of cereal types with a retarded development in the first growth stages, which are thus more drought-resistant during the stage when the tillers are formed. The ecotype established for wheat by N.L. Udol'skaya* is distinguished by a prolonged tillering period. It is also distinguished by a branchy and semi-rambling form of plant and a widely ramifying root system. When experiencing unfavorable spring conditions, such types, for example, are the most widespread standard Csezium 0111, develop successfully during the later stages. Similar ecotypes have also been established for other crops. The soils of the region are chernozems.

The Western Siberian steppe is chiefly a region of spring wheat cultivation. In the South there are considerable numbers of fields sown with millet. In the Omsk region in recent decades, the cultivation of sunflower and oil flax has begun spreading widely.

In addition to Csezium 0111 spring wheat, in the most southerly areas with a prolonged growth period, the standard type is Milturum 0321. Both types have been developed by the Western Siberian Experimental Station. Hard wheat Hordeiforme 010 of the Dnepropetrovsk Experimental Station grows successfully here, particularly at the junction with the forest steppe.

The types raised are distinguished by a comparatively slow growth period. Particularly important for enduring unfavorable drought conditions is the selection of types growing slowly through the first developmental phases.

62. West Siberian Forest Steppe Region

The region of the Western Siberian forest-steppe related to the steppe and changing gradually from steppe to forest-steppe stretches towards the Chelyabinsk-Shadrinsk-Kurgan-Ishim-Barabinsk area. Considerable areas of forest steppe are concentrated south of Novosibirsk towards Barnaul, between Barnaul and Biisk, from which they extend in narrow tongues towards Semipalatinsk. The northern areas of the Siberian forest-steppe are characterized by birch trees on leached chernozems and also by a comparative insufficiency of humidity.

The southern climate is even drier, approaching the steppe climate. The amount of rainfall characterizing the forest steppe areas varies from 350-480 mm. The climatic data are presented in Table 74.

Standard types for Western Siberian forest steppes are Csezium 0111, Milturum 0321, Hordeiforme 010, and the oat types Pobeda (Victory) and Lokhovskif. In essence, types of the steppe region exist in the forest-steppe, and in general it is not always easy to establish, both ecologically and in the sense of a type, a sharp demarcation between the forest-steppe and the steppe area.

* N.L. Udol'skaya, Drought Resistance of Varieties of Spring Wheat. Omsk, 1936.

Table 73

Climatic data of the region of the Western Siberian Steppes

Place	Data	Month												January
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Chelyabinsk 55°10' North lat. Elev. 228 m	Precipitation (mm)	14	10	10	17	35	54	75	50	27	27	23	20	362
	Av. temp. (°C)	-16.2	-14.0	-8.3	2.1	11.7	16.5	18.6	16.3	10.3	1.7	-6.7	-13.0	1.6
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-35.3
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-45.4
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	140
Omsk 54°58' North lat. Elev. 88 m	Frost-free days	-	-	-	-	-	-	-	-	-	-	-	-	124
	Precipitation (mm)	16	8	7	12	30	51	53	45	28	23	13	22	313
	Av. temp. (°C)	-19.6	-17.4	-11.8	0.2	11.4	7.2	19.9	16.9	10.7	1.3	-9.0	-16.0	-0.5
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-40.6
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-48.8
Kurgan 55°27' North lat. Elev. 88 m	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	157
	Frost-free period	-	-	-	-	-	-	-	-	-	-	-	-	121
	Precipitation (mm)	15	10	12	16	34	56	53	44	25	18	20	23	326
	Av. temp. (°C)	-18.3	-16.2	-10.3	1.2	11.2	16.2	18.3	15.8	9.6	1.0	-8.3	-14.5	0.5
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-38.2
Akmolinsk 51° 10' North lat. Elev. 347 m	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-46.2
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	159
	Precipitation (mm)	21	17	21	18	31	53	37	39	26	34	19	18	334
	Av. temp. (°C)	-17.0	-16.5	-11.0	0.9	12.8	17.8	20.3	17.8	11.1	1.7	-7.3	-13.6	1.4
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-38.0
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-48.9
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	164
	Frost-free period	-	-	-	-	-	-	-	-	-	-	-	-	129

Table 73
(continued)

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Semipalatinsk 50°20' North lat. Elev. 347 m	Precipitation (mm)	20	12	12	15	25	42	32	26	16	30	27	22	279
	Av. temp. (°C)	-16.0	-15.8	-9.9	3.0	14.2	19.7	21.8	19.6	13.1	3.5	-6.4	-12.7	2.8
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-39.8
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-51.4
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	174
Kustanai 53°13' North lat. Elev. 171 m	Precipitation (mm)	6	6	6	14	26	38	46	34	26	27	14	9	232
	Av. temp. (°C)	-17.8	-17.0	-10.7	1.8	12.9	18.4	20.4	18.1	11.9	3.0	-6.4	-14.9	1.6

Climatic data of the Western Siberian Forest Steppe Region

Table 74

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Novosibirsk 55°00' North lat. Elev. 107 m	Precipitation	20	13	16	14	34	62	58	53	36	30	25	23	384
	Av. temp. (°C)	-10.3	-7.6	-11.5	-0.8	9.5	16.1	18.7	16.2	10.1	0.8	-9.7	-16.2	0.5
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-48.6
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-47.5
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	153
Barnaul 53°20' North lat. Elev. 162 m	Frost-free days	-	-	-	-	-	-	-	-	-	-	-	-	122
	Precipitation (mm)	19	12	12	15	93	42	54	43	29	30	26	24	397
	Av. temp. (°C)	-17.6	-16.1	-10.3	0.9	10.9	17.1	19.3	16.8	10.6	1.4	-8.5	-14.6	0.5
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-42.9
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-49.0
Biisk 52°32' North lat. Elev. 182 m	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	151
	Frost-free days	-	-	-	-	-	-	-	-	-	-	-	-	116
	Precipitation (mm)	20	9	13	29	46	49	72	65	42	48	29	25	447
	Av. temp. (°C)	-16.2	-15.7	-9.6	1.3	11.2	17.2	19.3	17.1	11.4	2.4	-8.1	-13.8	1.4
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	166
	Frost-free days	-	-	-	-	-	-	-	-	-	-	-	-	134

335
336

Table 75

Climatic data of the Taiga of Western Siberia

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Tobolsk 58°12'North lat. Elev. 108 m	Precipitation (mm)	14	11	13	14	42	55	73	59	48	32	22	22	405
	Av. temp. (°C)	-19.3	-15.5	-9.1	0	9.0	15.0	17.8	15.4	9.3	-0.2	-10.1	-16.2	-0.3
	Av. abs. annual temp. min. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-40.2
	Abs. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-45.1
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	151
Naryn 58°55'North lat. Elev. 57 m	Frost-free days	-	-	-	-	-	-	-	-	-	-	-	-	126
	Precipitation (mm)	21	12	21	14	31	61	73	70	41	34	29	23	430
	Av. temp. (°C)	-23.1	-17.3	-11.5	-2.6	5.9	14.1	18.2	15.2	8.4	-1.4	-12.9	-20.0	-2.3
	Days over +5°C	-	-	-	-	-	-	-	-	-	-	-	-	136
	Frost-free days	-	-	-	-	-	-	-	-	-	-	-	-	126

63. West Siberian Taiga Region

Large territories of Siberia are occupied by forests (Taiga). To the north stretches a wide zone of forests which, in places, reaches nearly to the borders of the continent at the sea. In this colossal territory, which is still far from having been tamed, agricultural lands are located at points lying among vast, quite often marshy forest stretches. The main crops of this region are barley, rye, oats, and the earliest types of spring wheat and potatoes. Sowing is chiefly done in the spring. The frostless period averages some 126 days. The climate is continental and severe, the typical figures being presented in Table 75.

64. Altai and Sayan Agricultural Region

The mountain areas of the Altai and Sayan, which are closely related to each other, may be combined as far as the flora of cultivated plants is concerned into a single agroecological region, including a large part of the Gorno Altai (Oïrot) and Khakas Autonomous Region, as well as the elevated areas of the Krasnoyarsk territory, including the area of Minusinsk.

This also includes the northeastern elevated part of Kazakhstan, administratively a part of the Eastern Kazakhstan Region.

The mountain relief and diversity of conditions of the northern and southern slopes cause the occurrence of a considerable variety of crops and types. Large areas are covered with forests. The soil conditions of the agricultural areas of the Altai and Sayan are highly variable. Along the river valleys are fertile chernozem soils, especially suitable for agricultural development. The chief concentration of sown fields is located around Minusinsk, where some hundreds of thousands of hectares are under the plow.

Another important concentration is located around the Gorno Altai (Oïrot-Tura) in the direction of Biisk. In Central Altai agriculture reaches a height of 1,300-1,900 meters above sea level. Experimental production sowings conducted by the All-Union Institute of Plant Breeding in 1935-1939 proved the possibility of introducing farming along the Chuiskii Highway, up to 1,700 meters above sea level at Kosh-Agach. The climatic conditions of the Altai Sayan agroecological region are characterized by low winter temperatures. The growth period is short. Morning frosts and cold dew make their appearance as early as the first half of August. Northern and Central Altai are characterized by a reduction in the amount of rainfall with elevation into the mountains. While in the area of Oïrot-Tura, located at a height of about 800-900 m, the amount of rainfall attains 600-700 mm; as we rise into the mountains by the Chuiskit Highway into Kosh-Agach at a height of 1,700 meters it falls to 150 mm. Agriculture here requires irrigation.

We present a few climatic data in Table 76.

The climatic data for the point Altaïskaya (49°10' north latitude), 960 m above sea level, are the following: temperature of the warmest month, 17.3° C. Coldest month: -14.8° C. Absolute temperature minimum: -39.2° C. Number of days in a year with temperatures higher than 5°-167.

In the Altai-Sayan agroecological region, the chief crops sown are spring wheat, spring rye, oats, barley and millet. From time to time we meet fields sown with flax and hemp.

Table 76
Climatic data of the Altai-Sayan Agricultural Areas

Place	Data	Month												Totals
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Minusinsk 53°43' North lat. Elev. 255 m	Precipitation (mm).....	10	5	6	13	31	53	53	64	31	20	11	11	307
	Av. temp. (°C).....	-19.4	-18.4	-9.5	2.0	10.7	18.0	20.6	17.6	10.0	1.1	-8.7	-16.5	0.6
	Av. abs. ann. min. temp (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	41.4
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-42.2
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	160
	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	113
Zaïsan 47°28' North lat.	Precipitation (mm).....	8	7	10	24	39	46	33	31	19	21	19	12	269
	Av. temp. (°C).....	-15.1	-13.4	-7.7	5.0	15.5	20.3	23.0	21.2	15.1	6.0	-6.0	-14.0	4.1
	Av. abs. ann. min. temp (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-34.6
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-40.2
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	187
	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	153

Of particular interest is the flora of types of cultivated plants in the Minusinsk territory, where agriculture is ancient. Together with the usual Siberian forms of fast-maturing wheats, which in the southern Altaï are found at 1,400 meters above sea level, there exist as admixtures and sometimes in pure form original "brown-eared" varieties — *T. vulgare* var. *fuliginosum* Al. Here the brown-eared varieties, in contrast to the red- and white-eared types, are an ancient variety apparently peculiar to the higher altitudes. The brown-eared forms are often encountered in the southern part of the Altaï at a height of 1,000 meters*.

A certain order may be observed in the distribution of the flora of wheat types. In the highest zone (above 900 m), the varieties var. *ferugineum* Al. and var. *milterum* Al. exist in the form of pure seeds, as well as the admixture var. *fuliginosum*. In the intermediate zone (over 600 meters), there is a predominance of var. *ferugineum* and var. *milterum*. Less often we meet var. *lutescens*-Al. In the lower zone (below 600), together with var. *ferugineum* and var. *milterum*, we meet comparatively frequently with var. *lutescens* and *erythrosperrum* Koern, but var. *fuliginosum* does not exist here. Winter wheat is frozen as a consequence of the poor snow cover. In the lower zone of the southern Altaï we occasionally encounter hard wheat and it is of interest that it is grown at a height of 1,000 meters.

Oats show a similarity to the local Vyatski types. Barley cultivation is the one which continues highest in the mountain, being found at 1,500 meters. Barley is represented mainly by six-rowed forms of var. *pallidum* Ser. The two-rowed barley var. *nutans* Schuebl. is met with as an admixture and only rarely in the pure form.

Rye in the Altaï is represented chiefly by spring forms, under the name Yaritsa. By rye here we usually mean winter rye. It often freezes from lack of snow, but where it does not it produces a poor yield. Yaritsa (spring rye) is one of the old crops in existence here, apparently pre-dating even the arrival of Russian settlers. Yaritsa bread is of a good quality, tastier and of lighter color than bread from winter rye.

In the Altaï, considerable quantities of millet are cultivated, which are distinguished by a very motley botanical flora. Flax is cultivated in the mountains as high as 1,200 m. It is exclusively of the long-fiber type and is grown mainly for its fiber, with the use of the seeds at the same time for oil. This crop was undoubtedly introduced here by Russian settlers. Together with the cultivated hemp which is grown here occasionally, weed hemp (*Cannabis ruderalis* Janisch.), is widely grown here, being an invariable companion of man, and springing up wherever there is a concentration of humus, particularly in regions fertilized with manure. In the south of the Altaï hempweed is used in considerable quantities by the local population for fiber.

65. The Eastern Siberian Agroecological Region

This region includes the agricultural territories of the Irkutsk region and the Krasnoyarsk territory.

Agroecologically speaking the region also includes the forest zone of Mongolia, constituting a single geobotanical unit with Eastern Siberia.

The extensive territory of Eastern Siberia, in the general sense of the word, is, thanks to the mountainous relief, distinguished by unique conditions.

* E.N. Sinskaya. On the Field Crops of the Altaï. Tr. po prikladn. Botan., Genet. i Selekt. (Works in Applied Botany, Genetics, and Selection), Vol XIV, No 1, 192

The mountainous landscape causes a distribution of vegetation into horizontal strata, i.e., the high mountain woodland and subwoodland belts, the forest proper, and in the very south the steppe belt. The soils here consist of podzols, turfy podzolized soils, grey forest soils, and leached chernozems. A large part of the territory of this agroecological region belongs to the forest zone. The agricultural lands are located in separate groups tending particularly to cover the steppe areas, with leached chernozems and grey forest soils.

To the west of Lake Baikal agricultural areas occur in the meadow steppe islands lying amidst pine and larch-pine forests.

340 Further south, in the foothills and mountains of the Eastern Sayan fir-cedar, spruce-cedar-fir, and spruce-cedar forests are abundant. Further to the east of Lake Baikal, in the Trans-Baikal area, agriculture is also chiefly of the steppe kind, but now of a drier kind (tansies or grassy cereals) located in inter-mountain hollows and valleys (the areas of Ulan-Ude, Chita and Nerchinsk). The larch-pine and pine forests occupy the slopes and elevated water-sheds, being replaced higher up in the mountains by mountain larch and cedar-larch forests.

The climate is severe, continental and dry. The snow cover is insignificant. Wintering conditions are unfavorable: temperatures fall to -40°C and lower. Spring sets in later and autumn earlier than at the same latitudes in the European part of the USSR. The growing season is short, about 110-118 days. The amount of rainfall varies from 150-700 mm. Sowing is exclusively in the spring.

The chief difficulty for the cultivation of plants consists in the severe spring drought. For this reason, in selecting strains, particular attention has been directed to choosing ecotypes that germinate and send up stalks slowly. Decided value also attaches to selection for quick maturing plants. Table 77 presents typical climatic data for the region.

The climatic data for the point Kansk ($56^{\circ}12'$ north latitude, elevation 207 m) are the following: Temperature of the warmest month: $+19.0^{\circ}\text{C}$; coldest month -19.7°C . Absolute temperature minimum -50.3°C . Average of absolute minima of temperature -44.8°C . The number of days per year with temperatures above $+5^{\circ}\text{C}$ is 148. The frost-free season period is 108 days.

First place among Eastern Siberian crops is occupied by spring wheat, barley, oats (Figure 162), spring (Figure 163) and winter rye, and peas. Occasionally peculiar branched forms of rapidly maturing millet are cultivated. The type of flora is exceptionally closely related to that of the northern areas of Mongolia in climate and landscape belonging to the same ecological region as Eastern Siberia.

As shown by the expedition conducted by Professor V.E. Pisarev (1921-1922), the origin itself of the local flora of types of Eastern Siberia is related to the north of Mongolia and reflects the influence of Chinese agriculture. But under the conditions of a brief growing season, the local range of types was subjected to the marked influence of natural selection.

The local types of spring wheat are generally represented by rapidly maturing spring wheats of the type *T. vulgare* var. *ferrugineum sibericum* Flaks. more rarely by the beardless wheats, var. *lutescens*, with a small red grain, small ear without great demands for warmth during maturation, low height and only slight foliage, and easily sown, but with a tendency to infection by stinking smut. This peculiar Siberian group of wheats served as the point of origin for the spread of wheat cultivation in Alaska and partly in Canada. It is also represented in the far north in the Arctic region of the European part of the USSR.

Climatic data of Eastern Siberia Agroecological Region

Table 77

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Irkutsk 52°16' North lat. Elev. 467 m	Precipitation (mm).....	10	8	7	16	32	57	78	69	43	17	16	16	369
	Av. temp. (°C).....	-21.2	-18.8	-9.5	0.7	8.7	15.5	18.0	15.5	8.3	0.3	-10.4	-17.9	-0.9
	Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-41.9
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-50.2
	Days over + 5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	146
Tulun 54°33' North lat. Elev. 482 m	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	95
	Precipitation (mm).....	11	10	5	11	29	47	81	71	40	17	16	12	350
	Av. temp. (°C).....	-22.5	-18.9	-9.8	-0.1	8.3	15.2	17.8	15.0	7.3	-1.4	-11.8	-19.1	-1.7
	Days over + 5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	140
	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	78
Krasnoyarsk 56°01' North lat. Elev. 154 m	Precipitation (mm).....	6	6	6	11	30	43	53	68	35	22	16	12	308
	Av. temp. (°C).....	-18.2	-15.5	-7.3	1.3	9.6	17.0	19.9	17.1	9.9	1.4	-9.3	-14.9	1.0
	Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-40.3
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-47.1
	Days over + 5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	155
Nizhneudinsk 54°55' North lat. Elev. 414 m	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	120
	Precipitation (mm).....	11	10	7	14	32	46	91	64	32	23	16	14	360
	Av. temp. (°C).....	-22.0	-18.6	-10.3	0.3	8.1	15.1	17.5	14.8	8.1	-0.6	-11.3	-19.0	-1.5
	Days over + 5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	146
	Precipitation (mm).....	15	11	7	14	30	54	84	64	47	17	21	23	387
Zima 53°53' North lat. Elev. 458 m	Av. temp. (°C).....	-24.0	-20.0	-11.5	0	9.2	15.3	18.1	15.1	7.8	-0.8	-12.7	-20.7	-2.1
	Days over + 5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	143
	Precipitation (mm).....	25	15	15	22	37	61	67	73	44	39	37	31	468
	Av. temp. (°C).....	-22.2	-18.2	-10.6	-1.4	7.0	15.1	18.9	15.6	8.3	-1.9	-12.5	-20.0	-1.8
	Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-48.2
Eniseisk 58°27' North lat. Elev. 78 m	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-56.9
	Days over + 5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	140
	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	107
	Precipitation (mm).....	-	-	-	-	-	-	-	-	-	-	-	-	-
	Av. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-

In this region also four-rowed barley is widely grown, distinguished by non-fine awns, small grain, and comparatively low height. Peas belong mainly to the Pelyushka strain, with a vari-colored small grain, distinguished by slow development in the early part of growth and for this reason resistant to spring drought. Spring rye — Yaritsa — also grows here.

343

As a result of the work of the selection stations in Krasnoyarsk, Irkutsk and Tulun, a series of valuable types of spring wheat has been made available, including Leda, Tulun 81/4 (Balaganka), and others, whose specific areas are Eastern Siberia.



FIGURE 162. Sown oats — Avena sativa L., Tulun 86/5 variety, Eastern Siberia



FIGURE 163. Cultivated rye — Secale cereale L., spring form Yaritsa, Eastern Siberia

66. The Trans-Baikal Buryat Mongolian Agroecological Region

The natural vegetation of the agricultural areas located east of Lake Baikal (Trans-Baikal area) is constituted of considerable steppe stretches and rare deciduous forests or pine forest with steppe elements. This steppe character or firmly implanted steppe elements make the southern part of Trans-Baikal in the vicinity of the Trans-Siberian Railway distinctly different from the areas west of Lake Baikal.

344 Such are the areas of Ulan-Ude, Chita, Kyakhta, Nerchinsk and Sretensk. But in this part of the Trans-Baikal we also find larch, hilly, comparatively rare, sparse forests covering large stretches north of Chita and Nerchinsk.

The climate is comparatively dry. The rainfall varies between 200 and 325 mm. In this respect, it is inferior to the region discussed in the preceding section.

The climatic data is presented in Table 78.

The flora of cultivated plants is similar to that of the former region. Mainly spring awned wheats of the Sibirka type are grown less often with an admixture of beardless wheats. Its characteristic features are: smallness of grain, low height and rapidity of maturation. Barley is chiefly four-rowed, of medium height and but scant foliage. The winter rye includes forms exceptionally resistant to cold, and in addition distinguished by a tendency to self-pollination. Local types of branchy millet are fairly often grown, as well as peas, of the Pelyushka type. On the whole, the agricultural flora of Buryat-Mongolia is related in origin to the cultivated flora of the northeastern part of Mongolia. Until very recently local types were sown here to a very considerable extent represented by valuable populations in terms of resistance to drought, short growing periods and modest demands on the external conditions.

67. Yakutsk Agroecological Region

The Yakutsk agroecological region is part of a forest zone consisting principally of coniferous (larch) forests. Agriculture is located mainly along the rivers, both the Lena River itself and its tributaries—the Vilyuy and Aldan and along the valley of the Amga River which enters the Aldan, where at the present time an agricultural concentration of some 100,000 hectares is located. Plowing on a particularly large scale has been carried out in the past decade.

The fields themselves are concentrated on steppe meadows in the vicinity of rivers, in conjunction with plots of halophyte vegetation on the catchments.

The soils are podzolized loam and sandy loam, but with a pronounced tendency to accumulate humus and also, as it were, to form a transition to degraded chernozems.

Among the natural vegetation the wild steppe feather grass (Stipa pulcherrima) is abundant, constituting a very characteristic indication of the soil and climatic characteristics of this region.

Correspondingly, notwithstanding its position and proximity to the Arctic Circle, spring wheats mature fully, particularly the local varieties of Sibirka and Teremok-Tr.compactum, thanks to the high degree of warmth in the summer even white grain forms mature here, borrowed apparently from Tian-shan'. Four-rowed barleys, spring rye, oats, and leguminous seed crops — Pelyushka peas — grow well. The cultivation of cereals is carried out far beyond the Arctic Circle — up to Verkhoyansk.

The climatic data of this region are given in Table 79.

68. Amur Agroecological Region

A considerable part of the sown areas is located along the river Amur and its tributaries, the Zeya, Burlya, Arguna and Gazimur, administratively forming a part of the Khabarovsk and Maritime Region in the Amur region, and partly extending into the eastern part of the Chita region. The main agricultural concentrations are grouped round the town of Blagoveshchensk.

Table 78
Climatic data of the Trans-Baikal (Buriat-Mongol), Agroecological Region

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Ulan-Ude, Buriat Mongolian ASSR 51°49' North lat. Elev. 542 m	Precipitation(mm).....	4	1	2	6	12	27	65	39	24	8	9	7	204
	Av. temp. (°C).....	-21.1	-26.0	-21.8	-10.6	0.6	9.1	16.9	20.0	17.0	8.9	-0.3	-13.0	-1.7
	Av. abs. ann. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	-43.7
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	-49.2
	Days over +5° C.....	—	—	—	—	—	—	—	—	—	—	—	—	147
Nerchinsk 51°58' North lat. Elev. 490 m	Frost free days.....	—	—	—	—	—	—	—	—	—	—	—	—	92
	Precipitation(mm).....	2	3	4	10	24	38	71	72	34	11	7	5	281
	Av. temp. (°C).....	-31.0	-21.8	-14.3	0.3	9.1	17.6	21.0	16.9	9.9	-1.4	-15.7	-27.0	-3.3
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	-53.5
	Days over +5° C.....	—	—	—	—	—	—	—	—	—	—	—	—	150
Chita 52°02' North lat. Elev. 674 m	Frost-free days.....	—	—	—	—	—	—	—	—	—	—	—	—	96
	Precipitation(mm).....	2	2	3	8	28	46	90	84	33	13	5	5	319
	Av. temp. (°C).....	-27.7	-22.6	-12.2	-0.1	8.1	16.1	19.0	15.5	8.2	-1.6	-14.1	-23.6	-2.9
	Av. abs. ann. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	-44.0
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	-49.0
Buriat Kiakhta Mongolian ASSR 50°21' North lat. Elev. 770 m	Days over +5° C.....	—	—	—	—	—	—	—	—	—	—	—	—	143
	Precipitation(mm).....	3	2	2	6	21	37	81	74	37	8	4	5	280
	Av. temp. (°C).....	-22.1	-27.4	-21.6	-9.6	2.6	10.1	18.9	20.3	16.6	9.3	-0.1	-12.7	-1.3
	Days over +5° C.....	—	—	—	—	—	—	—	—	—	—	—	—	159
	Precipitation(mm).....	6	4	4	12	21	43	85	84	35	11	9	8	322
Petrovsk- Zabaikal'skiĭ 51°17' North lat. Elev. 801 m	Av. temp. (°C).....	-28.4	-32.9	-13.9	-1.7	6.5	13.8	16.7	13.6	6.1	-3.3	-15.2	-24.0	-5.2
	Av. abs. ann. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	-47.6
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	-54.8
	Days over +5° C.....	—	—	—	—	—	—	—	—	—	—	—	—	131
	Precipitation(mm).....	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 78 (continued)

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Σ 12 m
Mondy* 51°40' North lat. Elev. 1310 m	{ Precipitation(mm).....												303
	{ Av. temp. (°C).....												-2.6
	{ Days over +5° C.....												125
Barguzin 53°37' North lat. Elev. 507 m	{ Precipitation(mm).....												260
	{ Av. temp. (°C).....												-2.9
	{ Av. abs. ann. min. temp. (°C).....												-47.0
	{ Abs. min. temp. (°C).....												-49.7
	{ Days over +5° C.....												145
Kabansk 52°03' North lat. Elev. 467 m	{ Precipitation(mm).....												396
	{ Av. temp. (°C).....												-1.0
	{ Abs. av. ann. min. temp. (°C).....												-37.0
	{ Abs. min. temp. (°C).....												-41.4
	{ Days over +5° C.....												146
	{ Frost free days.....												119
Sretensk 52°15' North lat. Elev. 447 m	{ Precipitation(mm).....												323
	{ Av. temp. (°C).....												-4.4
	{ Abs. av. ann. min. temp. (°C).....												-47.3
	{ Abs. min. temp. (°C).....												-55.0
	{ Days over +5° C.....												146
	{ Frost free days.....												107

* Average for 9 years.

Particularly important concentrations of tilled areas are located on the steppe stretches or in the zones of the rare larch forests. Around Blagoveshchensk, considerable plowing has been carried out over a cleared territory in the larch and particularly oak forest. In Birobidjan, the farmed fields are concentrated principally amidst the plowed up cedar-spruce wide-leaf forests. On the whole, we find a fairly diverse assortment as we proceed from Sretensk to Blagovieschensk and Birobidzhan in the cleared areas and steppe spaces. The natural vegetation tends towards oak forests and spruce-cedar-fir mountain forests, surrounding the Birobidzhan area.

On the whole the region is characterized by adequate humidity, particularly in the summer. Winter is comparatively snowless, with a deep-frozen soil. A typical feature is the cold late spring. Considerable quantities of solar heat go to warming up the frozen soil. The beginning of summer is warm, later becoming hot and humid. The frost-free season is some 130 days.

The absolute minima of temperature fall to -40°C and even lower (see Table 80). Spring cereals are the sole types grown, mainly spring wheats and oats and less often barley. We encounter fields sown with rapidly maturing types of soya, selected from the local Korean assortment of the Amur experimental Station.

The standard types of Spring wheat of the Amur agroecological region are *Lutescens* 063, *Huron*, *Shtruke* and the Amur naked-ear type.

69. Far Eastern Maritime Agroecological Region

Geographically, this region comprises the areas from Habarovsk to Vladivostok, mainly located along the Amur. The natural vegetation is wide-leaf oak and cedar-spruce forests; in the middle, between the Amur and the coastal zone along the Pacific ocean, mainly spruce-cedar-fir forests are located. The concentrations of agriculture are located chiefly along the railway near the Amur and along the river Ussuri, around Lake Hamka. Small expanses of sown fields also exist along the coast of the Pacific Ocean.

On the whole this region is characterized by severe winters, sharp temperature drops and deep soil freezing. The frostless period lasts some 145-160 days; in Vladivostok up to 185 days. In the north at Nikolaievsk, on the Amur, the climate is considerably harsher and the frost-free season drops to 118 days.

Thus, the region is fairly varied, as may be judged from the example of the climatic data from three points: Habarovsk, Voroshilov (Nikolks Ussuriisk) and Vladivostok (Table 81).

Chiefly spring crops are cultivated. The standard spring wheat is *Struba*. Soya, Western European oats and barley are grown successfully. The main menace to wheat is stem-rust and fusaria (fusariosis).

Table 79
Climatic data of the Yakutsk Agroecological Region

Place	Data	Month												Σ
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Verkhoyansk 67°33' North lat. Elev. 122 m	Precipitation(mm).....	4	3	3	4	7	22	27	26	13	8	7	4	128
	Av. temp. (°C).....	-50.1	-44.3	-30.2	-13.1	1.5	12.6	15.1	10.8	2.4	-14.6	-36.8	-46.5	-16.1
	Av. abs. ann. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-61.7
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-67.6
	Days over +5° C.....	-	-	-	-	-	-	-	-	-	-	-	-	105
Rodchevo 66°18' North lat. Elev. 60m	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	73
	Precipitation(mm).....	15	10	5	5	12	22	62	42	28	11	19	16	248
	Av. temp. (°C).....	-40.0	35.0	-27.0	-12.9	1.1	13.0	14.4	10.1	-4.0	-10.0	-28.0	-36.8	-12.9
	Days over +5° C.....	-	-	-	-	-	-	-	-	-	-	-	-	106
	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	-
Yakutsk 62°01' North lat. Elev. 102 m	Precipitation(mm).....	6	5	3	6	13	27	34	42	22	12	10	7	187
	Av. temp. (°C).....	-43.5	-35.3	-22.2	-7.9	5.5	15.5	19.0	14.5	6.0	-8.0	-28.0	-40.0	-10.4
	Av. abs. ann. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-58.0
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-69.1
	Days over +5° C.....	-	-	-	-	-	-	-	-	-	-	-	-	125
Olekminsk 60°22' North lat. Elev. 152 m	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	98
	Precipitation(mm).....	10	7	6	10	24	42	41	54	32	17	17	12	272
	Av. temp. (°C).....	-35.4	-28.0	-18.3	-5.3	6.7	14.7	18.9	14.6	6.9	-4.7	-20.9	-32.1	-7.0
	Av. abs. ann. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-55.9
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-58.9
	Days over +5° C.....	-	-	-	-	-	-	-	-	-	-	-	-	129
	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	102

70. Arctic Eurasian Agroecological Region

The whole of the far north within the boundaries of European Asia (above 62° north latitude), has been classified by us in the agroecological region, the extreme northern parts of which are covered by forest-tundra and tundra. The southern stretches are occupied by coniferous forests with considerable concentrations of light soils. Agroecologically speaking, the region is mainly suitable for pasturage. It is characterized by podzolized marshy stretches with isolated spots of light soils. The plowed areas are chiefly used for the cultivation of barley, oats, and potatoes. Winter rye and perennial fodder grasses are also cultivated. Oats, barley, roots, tubers, and vegetables are grown with success. The growing period is very short, consisting of 60-90 days. Agriculture is practiced chiefly in the vicinity of mining areas, and far to the north mainly along the valleys of rivers, as a result of good drainage conditions. The entire territory is characterized by much daylight, a brief growth period, the destructive action of low temperatures, and the possibility of frost at any time during the growth period, especially in maturation. The low spring and end-of-summer temperatures are responsible for the phenomena of natural vernalization of crops both in the spring and in the maturing seeds on the root.



FIGURE 164. Hybrid of club wheat—Triticum compactum host. Jenkins, USA.



FIGURE 165. Sown oats — Avena sativa L., Markton variety; highly resistant to loose and stinking smut; USA

Climatic data of the Amur Agroecological Region (Blago Veschchensk) Table 80

Data	Month												Total
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Precipitation.....	8	1	12	26	39	78	130	138	73	19	5	1	525
Av. temp. (°C).....	-23.5	-18.0	-9.1	2.4	10.4	18.2	22.0	19.2	12.7	1.4	-10.9	-21.1	0.3
Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-37.5
Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-41.2
Days over +5° C.....	-	-	-	-	-	-	-	-	-	-	-	-	164
Frost free days	-	-	-	-	-	-	-	-	-	-	-	-	131

Climatic data of the Far East Littoral Agroecological Region Table 81

Place	Data	Month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Voroshilov 43°47' North lat. Elev. 25 m	Precipitation(mm).....	6	8	15	28	69	89	89	137	115	51	20	9	636
	Av. temp. (°C).....	-19.4	-15.1	-5.2	-5.3	11.4	15.9	20.3	21.4	15.0	6.5	-4.1	-14.7	2.2
	Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-37.1
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-43.0
	Days over +5° C.....	-	-	-	-	-	-	-	-	-	-	-	-	186
	Frost free days	-	-	-	-	-	-	-	-	-	-	-	-	147
Vladivostok 43°07' North lat. Elev. 2 m	Precipitation(mm).....	5	7	11	32	53	66	75	121	102	41	14	11	598
	Av. temp. (°C).....	-13.6	-10.3	-2.8	4.8	9.9	14.0	18.6	21.0	16.6	9.4	-0.6	-9.6	4.8
	Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-26.2
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-30.2
	Days over +5° C.....	-	-	-	-	-	-	-	-	-	-	-	-	194
	Frost free days	-	-	-	-	-	-	-	-	-	-	-	-	155
Khakarovsk 48°38' North lat. Elev. 75 m	Precipitation(mm).....	5	5	7	24	65	98	120	125	49	34	15	8	564
	Av. temp. (°C).....	-23.1	-17.4	-8.8	2.8	10.9	16.7	20.2	19.6	13.6	4.2	-8.3	-19.4	0.9
	Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-38.2
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-42.7
	Days over +5° C.....	-	-	-	-	-	-	-	-	-	-	-	-	172
	Frost free days	-	-	-	-	-	-	-	-	-	-	-	-	162

Table 82
Climatic data of the Agroecological Region of Europe

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Arkhangelsk 64°35' North lat. Elev. 6 m	Precipitation(mm).....	21	20	22	21	34	47	62	65	57	50	33	24	456
	Av. temp. (°C).....	-13.3	-12.4	-8.1	-1.1	5.2	11.5	15.3	12.9	7.6	1.0	-5.9	-11.0	0.2
	Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-35.8
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-44.8
	Days over +5° C.....	-	-	-	-	-	-	-	-	-	-	-	-	135
	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	120
Khibiny 67°44' North lat. Elev. 70 m	Precipitation.....	16	14	16	19	43	33	50	63	69	47	31	19	410
	Av. temp. (°C).....	-13.2	-12.9	-9.2	-2.0	3.0	8.8	13.1	11.2	3.0	-0.3	-6.6	-11.5	-1.4
Kem 64°57' North lat. Elev. 9 m	Precipitation(mm).....	20	16	17	22	30	51	67	73	68	49	30	23	466
	Av. temp. (°C).....	-11.1	-11.1	-7.6	-0.9	4.7	10.4	14.2	12.2	7.3	1.2	-4.6	-9.0	0.5
	Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-32.6
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-40.8
	Days over +5° C.....	-	-	-	-	-	-	-	-	-	-	-	-	193
	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	96
Ust-Tsilma 65°27' North lat. Elev. 25 m	Precipitation(mm).....	19	15	16	14	28	48	70	57	54	35	25	20	401
	Av. temp. (°C).....	-18.2	-15.8	-10.8	-3.0	9.1	9.7	14.4	11.6	5.9	-1.8	-10.1	-15.6	-2.6
	Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-43.0
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-51.1
	Days over +5° C.....	-	-	-	-	-	-	-	-	-	-	-	-	119
	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	88

Direct experiments carried out by the All-Union Institute of Plant Breeding's Arctic Station in Khibiny (67°44' north latitude) have shown the feasibility of cultivating not only rapidly maturing northern types but also southern annual strains. Our geographical experiments over many years have enabled us to confirm the maturability of the entire range of the world's assortment of barleys, including Mediterranean types from Tunisia and Algeria. The barleys of Ethiopia mature here regularly and in a completely normal fashion, as do many other barleys and oats originating from various agricultural areas of the world.

The quick completion of the growth period of the southern forms is apparently favored by the long day, while the low temperatures at the beginning of summer promote vernalization.

We present the climatic data for the region in Table 82.

On the Kola Peninsula, the Norwegian Mashin type of barley and other Norwegian types grow particularly well. In the vicinity of Arkhangelsk, local four-rowed barleys are grown. Of the oats, Finnish types, for example, Kiuto, grow particularly well.

Spring wheats can also mature, in particular in Siberia, where they are represented mainly by Siberka.

353

Winter rye, which is found here under cultivation, as already noted, is often represented by local types given to self-pollination. Among the wild forage grasses, for instance *Poa meadowgrasses*, apogamous forms are apparently fairly widespread here. The early types of potato, winter rape and turnip grow well, but peas and other leguminous seed crops do not always mature fully. In warm years, long-fiber flax ripens and, as the result of natural selection, a peculiar group of early northern long fiber forms developed, characterized by a high degree of speed of maturation and a lower height than the usual long fibers. In selecting types for the Arctic agroecological region, we must bear in mind ecological transformation caused by natural vernalization, thanks to the low temperatures and the effect of the long light day. As a result, many annual plants of even subtropical types, for instance, the decorative grassy types such as the snapdragon (*Antirrhinum majus*) and others, grow absolutely normally here. Tens of species of subtropical decorative grass and annual and perennial plants (the latter when they are uprooted in winter and stored in basements) vegetate and flower under these conditions just as in their own country.

Chapter IV

AGROECOLOGICAL REGIONS OF NORTH AMERICA,
AUSTRALIA AND SOUTHERN FRANCE

We now pass on to a consideration of the agroecological regions of continents where the cultivation of true cereals (wheat, barley, oats and rye), leguminous seed crops of the Old World, and flax developed only during recent centuries.

The wide development of these crops took place chiefly in the nineteenth and even twentieth centuries. The new conditions into which they were introduced made it imperative to carry out a great deal of selection, in the sense of both singling out the most suitable forms from the Old World group and the wide application of hybridization in recent decades (Figures 164-165) of representatives of the different agroecological groups, with a view to creating the most suitable combinations. As a result, not only was use made of already developed world varieties from the old agricultural lands of Europe and Asia, but new synthetic types and standards were created, which are of great practical interest for the areas of the Old World as well. It is sufficient to point to such American and Australian standard spring wheats as Marquis, Garnet, Regent, Thatcher, Federation, Aurora, Florence, Kanred, and others.

We may also note the Argentinian group of flaxes, which have a superlative yield, high oil content and immunity to fungal diseases, and which are peculiar to the most important centers of flax raising for the sake of the linseed. We will limit ourselves here to examining the elements represented by important concentrations of land sown with given plants or those featuring points of special interest in the sense of providing original material for selective purposes.

North America

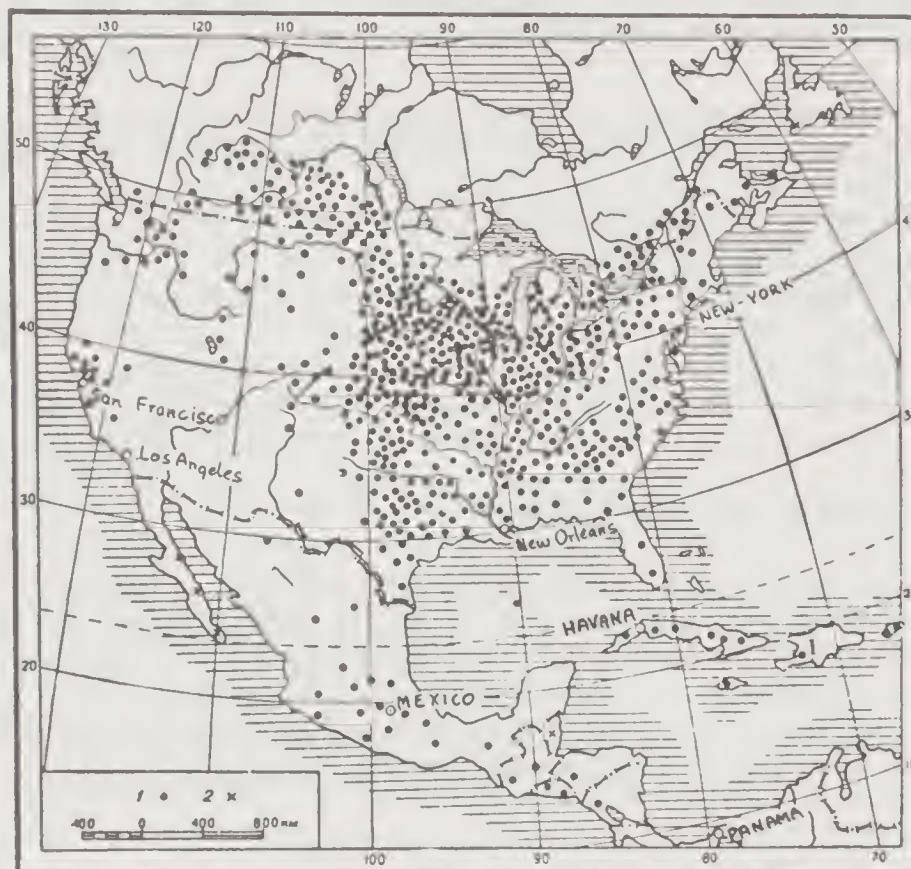
The cultivated area of the United States of America (1935-1940) is estimated to be approximately 130-135 million hectares, corresponding to 17% of the entire area of this country. Sown areas in Canada in the same period were estimated at 23 million hectares and areas under crops in Mexico in recent years have totalled 4 million hectares. Within the boundaries of North America 12 agroecological regions may be singled out in connection with the crops we are considering.

356

71. Western Canadian Forest Agroecological Region
72. Eastern Canadian Forest Agroecological Region (Quebec Province)
73. Agricultural regions of Alaska
74. Forest-steppe Agroecological Region of Canada.
75. Central Steppe Agroecological Region of Canada and USA
76. Southeastern Steppe Agroecological Region of the USA
77. Illinois Agroecological Region
78. Great Lakes Agroecological Region
79. Western Highlands Agroecological Region of the USA (Great Basin)
80. Northwestern Coastal Agroecological Region of USA
81. Southwestern Highland Agroecological Region of the USA
82. Southeastern Lowland Agroecological Region of the USA.
83. Mexican Highland Agroecological Region.

71. Western Canadian Forest Agroecological Region

The large territory of Canada has so far been but slightly exploited for agricultural purposes. Of the total area of 875.5 million hectares some 23,000,000 hectares have been devoted to agriculture yearly during recent decades, i.e., 2.5% in all. The forest region is the one least exploited for agriculture.



Map 6. North and Central America. Agricultural areas as of 1936 (cultivated and fallow areas, including gardens and vineyards). Each dot represents 250,000 hectares; x represents 16,000 hectares. Compiled by I. F. Makarov and I. V. Chekan. Editor: Acad. N. I. Vavilov.

357

The outstanding feature of the climate of Canada, as compared to the northern areas of the Soviet Union, consists in the fact that the agricultural areas of Canada are located at considerably more southern latitudes than the northern agricultural territory of the European part of the USSR. In addition, the farm belts lie parallel to latitude or else incline northwest and southeast. Furthermore, the northern Canadian agricultural areas are distinguished by a comparatively short growing season which constitutes a highly important factor for the emergence of natural and artificial selection. The duration of the frost-free period in Winnipeg, Regina and Saskatoon, the principal agricultural areas, is estimated at 115-120 days. For Lethbridge it is 116 days. Correspondingly, the growing season is even shorter.

The bulk of agricultural areas of Canada are devoted to spring types. Of the 10.5 million hectares under wheat, not more than 300,000 are devoted to winter wheat, and this chiefly south of the eastern areas of Ontario and Quebec provinces.

The forest zone of Canada possesses a cold, harsh climate. Wheats and barley are raised on lands which have been cleared from the forest. The western forest region of Canada, including a large portion of the lands of Alberta, Saskatchewan and Manitoba, has a growing season of 80-100 days. The destructive action of frosts often manifests itself here both in the spring and at the time of maturation of the cereals. The severity of the climate is aggravated by the considerable elevation above sea level. The rainfall is not high, varying from 270 to 405 mm, but the fact that it occurs during the growth period is favorable. The soil is poor and podzolized.

The climatic data of Fort Vermillion, Alberta, are as follows:
58°27' North latitude, elevation 290 meters, temperature of warmest month, 16°C, of coldest month, - 25.7°C. Days with temperatures over 5°C, 145. Annual rainfall, 312 mm, assured rainfall being 77 mm.

The climatic data for other points of this agroecological region are presented in Table 83.

The principal crops of the region are barley, oats, and spring wheat. The standard spring wheats for the region have not yet been established. According to the Canadian Crop Type Testing Service, crop types best cultivated here are: Spring wheat—Huron, Red Bobs, Early Triumph, Reliance, Reward, Garnet, and in certain years Marquis; barley—two-rowed Hannchen and four-rowed Trebi; peas—Arthur, Chancellor and Early Blue. The most successful flaxes are the oil-rich Bison, Buda, and Redwing. Large quantities of the Prelude variety of spring wheat are also sown.

72. Eastern Canadian Forest Agroecological Region (Quebec Province)

The areas of the southeastern provinces of Ontario and Quebec used for agriculture are characterized by a milder climate than the western Canadian forest region. The chief farm areas are around Montreal, Ottawa and Guelph.

This region differs distinctly from the preceding ones, primarily because of the greater amount of rainfall and the longer and warmer summer. There is no drought and even early varieties of corn may be raised for green forage. Due to the comparatively warm summer and abundance of rainfall, stem rust is a serious menace to cereals, particularly in the Southwest. In the South sugar beet succeeds extremely well. Seed and oil flaxes grow very well, the region being one of the best flax growing areas in Canada. Tobacco and peas also grow well. Leguminous seed crops find conditions very favorable. In the South, early types of French beans are grown. The soils are acid, podzolized, and poor. The natural vegetation is the coniferous forest.

We present characteristic climatic data in Table 84. In contrast to the preceding region, thanks to the abundant rainfall, considerable quantities of winter wheat are cultivated here, consisting of varieties developed by the Ottawa and the Svalob Experimental Stations. It is the principal winter wheat area in Canada. American Banner, Dawsens, Trumbul and Minturki are the accepted varieties. Ukrainian Kooperatorka and Buffum also grow here. Some of these types, such as Buffum, are extremely resistant to winter conditions when grown under the conditions of the non-chernozem areas of the USSR. In addition, two-rowed brewing barley and oats grow here.

Table 83
Climatic data of the Western Forest Agroecological Region of Canada

Place	Data	Month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Fort Chipewyan, Alberta 58°42' North lat. Elev. 218 m	Precipitation.....	18	13	18	18	20	36	58	41	30	23	23	20	318
	Av. temp. (°C).....	-25.1	-22.9	-15.6	-2.3	7.4	13.3	16.6	14.3	7.1	0.3	-9.9	-17.5	-2.8
	Av. abs. ann. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-42.4
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-50.8
	Days over +5° C.....	-	-	-	-	-	-	-	-	-	-	-	-	134
Prince Albert, Saskatchewan 53°40' North lat.	Precipitation.....	21	17	22	21	38	68	59	59	35	20	25	20	405
	Av. temp. (°C).....	-21.1	-18.5	-11.1	2.3	9.4	14.5	16.7	14.9	9.7	3.5	-7.5	-14.8	-0.2
	Av. abs. ann. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-41.9
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-56.7
	Days over +5° C.....	-	-	-	-	-	-	-	-	-	-	-	-	165
Beaver Lodge, Alberta 52°20' North lat. Elev. 610 m	Precipitation.....	24	12	13	22	16	91	72	44	25	20	13	13	365
	Av. temp. of January (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-20.5
	Av. temp. of July (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	15.5

73. The Agricultural Regions of Alaska

The total cultivated area of Alaska has been estimated in recent years at some 1600 hectares, of which some 200 hectares are under wheat and 400 under barley, followed by the potato and vegetable crops.

The amount of rainfall is comparatively small. The soils are podzolized. The growing season, as in the Arctic Region, is short. Alaska is characterized by long hours of daylight and probably influenced also by vernalizing action of the low temperatures at the beginning of summer. As in our own Arctic region, Alaska is characterized by a limited amount of rainfall and the occurrence of drought, destructive action of which is moderated by the slight evaporation. With such conditions of climate and soils, Alaska is in general close to the Eurasian Arctic region.

The climatic data recorded at Rampart, 65°30' north latitude, elevation 97 meters, are: Temperature of warmest month, 16°C; coldest month, -28.8°C; number of days with temperature over 5°C, 131; annual rainfall 254 mm. The climatic data for Fairbanks is presented in Table 85.

In the development of spring wheat varieties, use was made of northern Russian varieties, such as Ladoga and Siberka. In the creation of the barley ecotype, an important role was played by Ethiopian barley and hull-less and rapidly maturing forms from Europe. The method of prolonged selection was used to develop interesting assortments from northern Russian and Siberian local types. In addition, the method of simple selection was employed, as well as crossing, particularly of European and Ethiopian varieties of barley.

74. Forest-Steppe Agroecological Region of Canada

The principal agricultural areas of Canada are to be found in the forest-steppe region. Nearly nine-tenths of all wheat cultivation is concentrated precisely in the forest, forest-steppe and steppe sections of Canada. The forest-steppe agroecological region of Canada comprises the northern parts of the provinces of Alberta, Saskatchewan and Manitoba, where the soils are leached, while in the south they turn into degraded chernozems. The forest-steppe region is characterized by a short frostless period of 81-100 days, partly caused by the elevation of the agricultural areas above sea level. The humidity is average, but when the temperature is comparatively low it is adequate. The climatic data for this agroecological region are presented in Table 86.

Of the principal crops, spring wheat is here grown above all. One of the most important factors reducing its yield is stem rust, in fighting against which tenacious work is being carried out in the direction of breeding resistant types. In recent years it has become possible to achieve great success by adopting remote hybridization and repeated crossings. In this respect an important role has been played by new varieties raised by the Minnesota Experimental Station, such as Thatcher, and the numerous types developed by the Canadian Experimental Station, such as Apex, Renown (plant-breeder Goulden*), and also, most recently, by the Regent variety. The standard spring wheat types up to not long ago were Reward, Marquis, and Red Bobs. The two latter types are predominantly cultivated in the west.

* C.H. Goulden. Breeding Disease-Resistant Varieties of Wheat, in the book - Proceedings of the World's Grain Exposition, Regina, Canada, 1933, pp 29-37.

Table 84
Climatic data of the Eastern Forest Agroecological Region of Canada

Place	Data	Month												Σ
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Moose Factory, Ontario 51°15' North lat. Elev. 10 m	Precipitation(mm).....	34	14	22	25	75	82	129	126	102	54	46	37	746
	Av. temp. (°C).....	-19.8	-18.5	-11.7	-2.7	5.8	12.2	16.5	14.9	10.4	4.3	-5.4	-16.0	-0.8
Port Arthur, Ontario 48°27' North lat. Elev. 196 m	Av. temp. (°C).....	-15.1	-13.9	-7.8	1.4	7.9	13.3	16.7	15.4	11.3	4.8	-3.6	-10.6	1.6
	Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-34.6
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	166
	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	127
Quebec City 46°48' North lat. Elev. 90 m	Av. temp. (°C).....	-12.4	-10.6	-6.0	2.3	9.8	16.1	18.7	17.6	13.0	6.3	-1.7	-8.7	3.7
	Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-31.4
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	194
Montreal, Quebec 45°30' North lat. Elev. 57 m	Precipitation(mm).....	95	78	96	57	75	90	109	91	84	80	95	93	1043
	Av. temp. (°C).....	-10.9	-9.1	-4.3	4.8	12.6	18.3	20.5	19.3	14.7	7.8	-0.3	-7.1	5.6
	Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-27.4
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-32.8
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	194
Toronto, Ontario 43°39' North lat. Elev. 104 m	Frost-free days.....	-	-	-	-	-	-	-	-	-	-	-	-	177
	Precipitation(mm).....	66	58	63	60	77	73	76	73	83	62	78	70	839
	Av. temp. (°C).....	-5.3	-5.3	-1.8	5.1	11.3	16.9	19.8	19.1	14.8	7.9	2.3	-3.1	6.8

361
362

Table 85

Climatic data of the Agricultural Areas of Alaska (Fairbanks) 64°51' North lat., Elev. 150 m

Data	Month												Totals
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Precipitation.....	19	12	21	7	14	36	47	42	40	19	17	17	291
Av. temp. (°C).....	-24.8	-13.0	-11.8	-1.9	8.4	14.7	15.7	12.9	6.2	-3.1	-16.3	-21.8	- 2.9
Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-45.6

Table 86

Climatic data of the Forest-Steppe Agroecological Region of Canada

Place	Data	Month												Totals
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Calgary, Alberta 50°45' North lat.	Precipitation(mm).....	13	14	19	19	61	71	66	67	92	14	19	12	407
	Av. temp. (°C).....	-11.5	- 9.7	-3.8	4.4	9.4	13.3	15.9	14.8	10.3	5.5	-3.1	-6.4	3.3
	Av. abs. ann. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-36.3
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-42.8
	Days over +50 C.....	-	-	-	-	-	-	-	-	-	-	-	-	170
	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	81
Minnedosa, Manitoba 50°20' North lat.	Precipitation(mm).....	20	15	18	26	49	80	67	54	39	24	25	16	493
	Av. temp. (°C).....	-19.1	-17.7	-9.4	3.1	9.9	15.5	17.6	15.9	11.1	4.5	-5.7	-13.3	1.0
	Av. abs. ann. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-40.1
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-45.3
	Days over +50C.....	-	-	-	-	-	-	-	-	-	-	-	-	174
	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	79

Table 86(continued)

Winnipeg, Manitoba 49°56' North lat. Elev. 250 m	Precipitation(mm).....	31	19	40	39	55	77	83	55	53	96	25	23	516
	Av. temp. (°C).....	-15.7	-18.1	-9.3	3.7	10.8	17.0	19.0	17.1	12.3	5.3	-5.6	-13.8	1.5
	Av. abs. ann. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-37.9
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-43.6
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	179
	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	100
Brandon Manitoba 49°51' N. lat.	Precipitation(mm).....	23	11	23	26	60	65	72	66	44	17	22	23	456
	Av. temp. (°C).....	-26.3	-17.7	-8.0	3.5	9.4	15.8	18.3	16.7	12.2	4.9	-4.8	-13.7	1.4
Edmonton, Alberta 53°13' North lat. Elev. 658 m	Precipitation(mm).....	19	17	17	20	47	83	90	63	36	19	19	19	449
	Av. temp. (°C).....	-14.5	-11.9	-4.8	4.9	10.7	14.0	16.2	15.0	10.2	5.4	4.2	-8.9	3.4
	Av. abs. ann. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-40.1
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-46.7
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	182
Balford, Saskatchewan 52°40' North lat.	Precipitation (mm).....	11	7	10	10	39	84	63	44	39	15	11	13	346
	Av. temp. (°C).....	-19.7	-15.8	-6.7	4.3	10.3	16.1	17.9	16.2	11.7	5.0	-4.8	-12.6	1.8
	Av. abs. ann. min. temp. (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-41.0
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-51.7
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	179
Saskatoon, Saskatchewan 52°10' North lat. Elev. 415 m	Precipitation(mm).....	23	12	14	12	39	63	64	55	38	19	13	16	368
	Temp. of warmest month...	-	-	-	-	-	-	-	-	-	-	-	-	17.6
	Temp. of coldest month...	-	-	-	-	-	-	-	-	-	-	-	-	-18.8
	Av. abs. ann. min. temp (°C)...	-	-	-	-	-	-	-	-	-	-	-	-	-59.8
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-48.3
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	173
	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	96

Table 87
Climatic data of the Central Steppe Agroecological Region of Canada and the USA

Place	Data	Month												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Bismarck, North Dakota 46°47' North lat. Elev. 510 m	Precipitation.....	11	12	23	40	68	86	56	45	91	24	14	14	414
	Av. temp. (°C).....	13.2	-12.6	-4.6	5.4	12.7	17.7	21.1	19.6	14.4	6.8	-2.3	-9.7	4.6
	Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-35.6
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-42.8
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	199
Amenia, North Dakota Elev. 290 m	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	127
	Precipitation.....	13	10	14	48	72	98	76	69	50	33	14	13	510
	Av. temp. (°C).....	-15.3	-13.9	-4.7	5.7	12.3	17.5	20.4	19.0	14.0	6.8	-2.6	-10.7	4.1
	Min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-41.7
Brookings, South Dakota 44°20' North lat. Elev. 490 m	Precipitation.....	11	12	19	55	84	101	66	69	52	37	14	13	533
	Av. temp. (°C).....	-10.7	-9.7	-1.4	6.9	13.2	18.2	21.2	20.2	15.4	8.5	-0.1	-0.8	6.7
	Min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-40.6
Swift Current, Saskatchewan 50°15' North lat. Elev. 738 m	Precipitation(mm).....	16	17	19	20	49	78	81	48	30	19	14	16	385
	Av. temp. (°C).....	-14.9	-13.7	-5.8	5.2	10.7	15.7	18.7	17.4	11.8	5.6	-3.3	-8.3	3.4
	Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-36.6
	Min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-66.7
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	187
Havre, Montana 48°34' North lat. Elev. 458 m	Precipitation(mm).....	18	14	13	25	51	74	47	30	93	17	16	16	354
	Av. temp. (°C).....	-10.4	-10.2	-2.8	6.6	12.1	16.8	20.6	18.8	13.4	6.6	-0.6	-6.6	5.3
	Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-38.7
	Min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-49.4
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	196
Indian Head, Saskatchewan 50°15' N. lat. Elev. 610 m	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	124
	Precipitation.....	17	15	19	21	70	100	84	52	46	21	20	20	485

Table 87 (continued)

Miles City, Montana 46°25' North lat. Elev. 723 m	Precipitation.....	17	13	22	28	56	69	98	27	26	23	14	16	349
	Av. temp. (°C).....	-8.1	-8.2	-0.8	8.3	19.8	19.4	23.9	29.3	15.8	9.4	0.4	-5.3	8.1
	Min. Temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-53.9
	Days over +5°C.....	-	-	-	-	-	-	-	-	-	-	-	-	207
	Frost free days.....	-	-	-	-	-	-	-	-	-	-	-	-	146

Table 88
Climatic data of the South-Eastern Steppe Agroecological Region of the USA

Place	Data	Month												Σ T °C
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Lincoln, Nebraska 40°49' North lat. Elev. 362 m	Precipitation (mm).....	16	26	31	65	110	110	99	93	74	52	26	21	723
	Av. temp. (°C).....	-5.3	-3.4	2.9	10.7	16.5	21.9	24.8	23.5	18.9	12.0	3.6	-2.7	10.3
	Min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-26.6
Manhattan, Kansas 39°10' North lat. Elev. 327 m	Precipitation.....	20	31	38	68	115	114	117	92	85	57	37	23	797
	Av. temp. (°C).....	-1.7	-0.4	6.6	12.4	18.0	23.5	25.8	25.6	21.3	14.3	6.7	-0.4	12.7
	Min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-35.5
Hayes, Kansas 39°11' North lat. Elev. 610 m	Precipitation (mm).....	12	22	25	60	85	81	83	76	58	36	20	21	679
	Av. temp. (°C).....	-1.2	-0.6	5.7	11.0	16.5	22.2	25.5	25.1	20.2	13.8	5.7	-0.8	11.9
	Min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-31.0

75. Central Steppe Agroecological Region of Canada and the USA

A typical peculiarity of this agricultural region is the fact that it encompasses non-chernozem soils, which, in contrast to Eurasia, stretch in North America in a comparatively narrow strip not in the direction of the latitude but along the meridians from north to south. The climate is continental, characterized by a cold winter and hot summer. The frost-free period of the steppe zone of Canada is comparatively short, from 110-130 days. The climate of the region is dry. The amount of rain varies from 350-550 mm per year. In certain years, the destructive action of drought makes its appearance and in humid years mass infections of stem rust are observed, causing heavy losses, as in 1924 and particularly 1925.

The climatic data for this agroecological region are presented in Table 87. Just as in Western Siberia, there is a marked predominance in the steppe areas of Canada of spring-sowing over winter. Here is the center of the bulk of areas sown with spring wheat in the whole of North America. This includes the wheat areas of North and South Dakota, and northern Montana. Within Canada proper, this region includes the steppe areas of Manitoba, Saskatchewan, and part of Alberta. In addition to wheat-oats, barley, and seed-flax are grown. The potato and sugar beet grow not quite satisfactorily. Leguminous seed crops, such as peas, grow fairly well when sown in the autumn. The standard spring wheat for the region is the famous Marquis variety, which occupies huge areas and which predominates markedly over all other types. Of all the spring wheat types, Marquis, developed at the Ottawa Station by C.E. Saunders, takes up the greatest area in North America, satisfying most of the requirements, as it is non-recumbent, productive, comparatively drought-resistant and disease-resistant and possesses a grain with high flour-milling and bread-baking qualities.

In Southern Manitoba Province and Northern Montana, the Ceres type bred by L.R. Waldron is widespread, as is also standard hard wheat, such as Mindum and Acme. The past decade has seen complex inter-species hybrids beginning to spread, such as Thatcher, Regent, Apex, and Renown, which are resistant to stem rust and yield no less than does Marquis. Of the standard flaxes, we note the Bison, which is resistant to fusariosis and other diseases. It was bred at the North Dakota Station by H.L. Bolley.

76. Southeastern Steppe Agroecological Region of the USA

This region includes the states of Kansas, Missouri, northwest Oklahoma, southern Nebraska, western Tennessee and western Kentucky. The Region is part of the so-called zone of the Great Basin.

367 In this territory, in contrast to the preceding one, there is a preponderance of winter wheat, the area of which has attained 8,000,000 hectares. Winter is moderate, the average temperature in Kansas (Manhattan) being 1.7°C . In Hays, Kansas, it is 1.2° and in Nebraska (Lincoln) it is -5.3°C . The Kanred type of winter wheat winters quite satisfactorily here, while normally freezing readily when placed under conditions of the Ukrainian steppes. In humid years, particularly in the east, the destructive effect of brown rust quite often appears. All of the region is highly affected by the Hessian fly. During summer, a severe drought effect is often present, particularly in the western areas.

Typical climatic data for the agroecological region are presented in Table 88.

Table 89

Climatic data of the Illinois Agroecological Region

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Memphis, Tennessee 35°09' North lat. Elev. 126 m	Precipitation(mm).....	120	120	132	123	104	91	80	83	72	67	110	112	1214
	Av. temp. (°C).....	4.8	6.7	10.9	16.4	21.4	25.1	26.7	26.0	22.9	17.2	10.9	6.2	16.3
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—22.8
	Days over +5° C.....	—	—	—	—	—	—	—	—	—	—	—	—	365
	Frost free days.....	—	—	—	—	—	—	—	—	—	—	—	—	242
St. Louis, Mo. 38°38' North lat. Elev. 173 m	Precipitation(mm).....	58	70	84	98	108	98	75	75	89	68	73	55	951
	Av. temp. (°C).....	—0.8	1.2	6.3	13.1	19.3	23.7	25.8	25.1	20.9	14.3	7.1	1.4	13.1
	Av. abs. ann. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—13.9
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—25.0
	Days over +5° C.....	—	—	—	—	—	—	—	—	—	—	—	—	267
	Frost free days.....	—	—	—	—	—	—	—	—	—	—	—	—	211

The Kansas Experimental Station has succeeded by means of selection and crossing to produce a series of valuable types of winter wheat.

The standard types are hyaline winter wheat, above all Krimkas, known under the name of Turkey, and also types grown from the Krimkas, such as Black Hull and Tenmark. Of the spring barleys, the varieties Stavropol, Odessa and Trebi do well, as do Manchurian and Oderbrucker. In general climate these areas correspond to the most favorable areas of the Krasnodar and Stavropol territories, the Crimea, and the southern sufficiently humid steppe areas of the Ukraine. However, the winters are milder than in our steppe areas. The soils are mainly chestnut or dark brown.

77. Illinois Agroecological Region

This region comprises the area of the states of Iowa, Illinois, Missouri, Indiana, Ohio and partly the states bordering these. Here lies the "Corn Belt", where up to 30% of the entire global corn harvest is raised.

The soils are brown. The natural vegetation is deciduous forests. The winters are comparatively mild. For this reason, varieties with medium resistance to winter conditions grow successfully. In general, the region has an ideal climate for wheat raising. The amount of rainfall goes as high as 1000 and in some places more than 1000 mm. The winter wheats are less resistant to winter conditions than in the preceding region. Such types as Nittany are found; the Banatka grow successfully, and it is also possible to raise Mediterranean oats. Table 89 presents the climatic data for the region.

78. Great Lakes Agroecological Region of the USA

This includes the states of Minnesota, Wisconsin, Michigan and northern New York. The region is part of the forest zone in the North and the forest steppe zone in the South.

In the past, agriculture was considerably more highly developed here than at present. As a result of the mechanization of agriculture in the USA, particularly the large-scale use of combines, much of the agricultural area was abandoned in view of the uneven terrain and insufficient fertility of the soils. On the whole the region is characterized by a cold climate, cool summers, and severe winters. In St. Paul, Minnesota, the average rainfall is 685 mm; in Ithaca, New York 822 mm, and in Lansing, Michigan, 755 mm.

Both winter and spring wheats are here cultivated and, from time to time in the South, hard wheats. Considerable quantities of barley are found.

In addition to the severe winter, another unfavorable condition is the frequent blighting of the wheat with stem rust.

The climatic data for the region are presented in Table 90.

The standard types for the Great Lake agroecological region are the Minhardi and Minturki bred by crossing various lines of Soviet Crimean winter types. Of the spring wheat, the standard up to not long ago was provided by the Marquis variety, subsequently displaced by the Ceres, and in very recent years displaced by the Thatcher variety.

Of the barleys, the chief varieties are Glabron, Minnesota 184 and Lion. Flax types are represented by the medium-fibre Bison strain.

79. Western Highland Region of the USA (Great Basin)

This broad region encompasses a considerable part of the states of Washington, Oregon, Nevada, Idaho, Utah, the western half of Wyoming, Western Montana, and Colorado. The principal area lies between the Rocky and Cascade Mountains and the Sierra Nevada. On the whole the region is a dry one, with rainfall varying from 130 mm (Tacoma, Nevada) to 526 mm (Pullman, Washington). Accordingly, both irrigated and non-irrigated cultivation is employed. The growing season, as a result of the elevation above sea level, is brief. The mountain terrain causes a variety of climates and soil conditions in the various areas and accordingly a variety of flora and types.

We present the climatic data (Table 91) from which it is seen that summer is the dry period. The maximum rainfall occurs in autumn, winter and to some extent spring, i. e., the rainfall and temperature distribution to some extent resembles the climate of the Mediterranean area.

373

The chief crops are wheat and barley, sown mainly in the autumn. During the spring, sugar beet is planted and from time to time flax, leguminous seed crops, and potatoes. Corn suffers from drought occasionally, but is being grown on irrigated sections.

The soils of the region are represented essentially by steppe serozems (grey-earths) relatively poor in organic matter and more or less alkaline. Many salty stretches are encountered. The natural vegetation has a steppe-like character. The flora of varieties of cereals differs considerably from that of other regions of the USA. Here, both spring and winter types are grown. The Australian strains of spring wheat (Federation) are cultivated with success, as are certain dwarf wheats bred by Dr. Gaines at the Experimental Station at Pullman. We note the Redit variety, obtained by the crossing of Crimean Turkey wheat with the Australian Florence type. Redit is resistant to various forms of smut and its grain does not shatter readily. Thanks to intensive work by the Experimental Station of the State of Washington (Pullman), the varieties of the region are appropriate to a high degree for local conditions. Of particular interest is the original type of oats called Markton which is resistant to both loose and covered smut. Among the barleys, selected smooth-bearded types have spread here in recent years.

80. Northwestern Coastal Agroecological Region of the USA

Territorially speaking, this includes the western coastal agricultural areas of Washington and Oregon and the coastal agricultural areas of the State of California. The proximity to the Pacific Ocean and the fact that the area is shielded by mountains have created specific agricultural conditions. Rainfall, for example in Tacoma, Washington, amounts to 1050 mm. Here, as in the neighboring coastal areas, rain falls in the autumn, winter and spring months. The driest months are those of summer, i. e., the climate is similar to the Mediterranean climate, differing only by the lower temperatures. Winter conditions are favorable. Semi-winter and winter forms of barley are grown, as well as soft and English wheat and Mediterranean oats, resistant to coronal rust, among them the standard Markton, which morphologically resembles common oats, but is distinguished by immunity to loose and stinking smut, in which respect it is similar to A. byzantina.

Climatic data of the Great Lakes Agroecological Region of the USA

Table 90

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Marquette, Michigan 46°34' North lat. Elev. 224 m	{ Precipitation(mm).....	58	52	56	63	74	83	78	67	84	69	75	67	826
	{ Av. temp. (°C).....	-8.7	-8.3	-3.9	3.2	9.3	14.8	18.2	17.6	14.1	8.0	0.7	-5.2	4.9
	{ Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-25.9
	{ Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-32.8
Ithaca, N. Y. 42°27' North lat. Elev. 255 m	{ Precipitation(mm).....	55	54	58	65	84	91	88	84	79	75	61	52	846
	{ Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-23.2
	{ Precipitation(mm).....	23	20	35	59	83	108	79	91	88	42	39	23	690
	{ Av. temp. (°C).....	-11.2	-8.4	-2.6	5.9	14.4	19.6	21.6	19.7	14.3	7.2	-0.9	-9.3	5.8
St. Paul, Minn. 44°58' North lat. Elev. 255 m	{ Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-31.1
	{ Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-40.6
	{ Precipitation(mm).....	40	38	51	65	96	99	94	79	85	60	45	40	792
	{ Av. temp. (°C).....	-8.5	-7.4	-0.6	7.5	14.1	19.5	22.3	20.9	16.7	10.1	1.8	-5.3	7.6
Madison, Wis. 43° North lat. Elev. 296 m	{ Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-34.0
	{ Precipitation(mm).....	-	-	-	-	-	-	-	-	-	-	-	-	-
	{ Av. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-
	{ Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 91
Climatic data of the Region of the Western Uplands of the USA

Place	Data	Month												Σ Σ Σ Σ
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Grass Valley, Oregon 45°20' North lat. Elev. 725 m	{ Precipitation(mm).....	41	26	20	17	33	27	3	6	12	20	41	38	284
	{ Av. temp. (°C).....	-1.4	0.6	5.0	8.2	10.5	13.8	18.3	17.6	12.7	8.8	4.1	-0.3	8.1
	{ Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-34.4
Spokane, Wash. 47°40' North lat. Elev. 588 m	{ Precipitation(mm).....	54	48	29	29	35	32	18	16	23	29	54	55	422
	{ Av. temp. (°C).....	-2.7	-0.6	3.9	8.8	12.7	16.8	20.3	19.4	14.8	8.6	3.4	-1.0	8.7
	{ Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	21.7
Pullman, Wash. 46°45' North lat. Elev. 777 m	{ Precipitation(mm).....	69	53	53	38	40	32	13	16	31	38	75	68	526
	{ Av. temp. (°C).....	-2.2	-0.1	3.8	8.1	11.7	15.6	20.1	19.6	14.1	9.3	3.3	0.8	8.6
	{ Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-27.8
Tecoma, Nevada Elev. 1466 m	{ Precipitation(mm).....	15	14	9	14	16	13	6	5	10	12	9	13	136
	{ Av. temp. (°C).....	-4.8	-2.6	2.7	7.6	11.6	12.2	21.0	19.2	14.0	7.5	1.0	-5.7	7.0
Ogden, Utah 41°19' North lat. Elev. 1219 m	{ Precipitation(mm).....	42	41	47	38	45	18	9	16	23	37	30	39	385
	{ Av. temp. (°C).....	-1.8	0.4	5.2	11.2	15.9	21.5	25.6	24.4	18.0	10.8	4.0	-0.6	11.2
	{ Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-26.7
Moab, Utah 38°41' North lat. Elev. 1219 m	{ Precipitation.....	23	17	23	16	19	8	22	17	26	23	17	24	235
	{ Av. temp. (°C).....	-1.8	2.3	6.3	12.9	17.5	22.3	25.4	24.0	12.0	12.0	5.2	-0.9	11.4
Helena, Mont. 46°34' North lat. Elev. 1253 m	{ Precipitation(mm).....	22	17	20	25	57	60	28	20	32	23	19	20	346
	{ Av. temp. (°C).....	-6.6	-5.0	0.1	6.4	11.1	15.3	19.1	18.6	13.6	6.8	0.5	-4.3	6.3
Lander, Wyo. 42°50' North lat. Elev. 1637 m	{ Precipitation(mm).....	14	17	29	53	56	29	18	19	23	39	15	17	321
	{ Av. temp. (°C).....	-7.7	-5.4	0.1	5.9	10.9	16.8	20.0	18.9	13.2	6.3	-1.1	-6.6	6.9

We present the climatic data for this region in Table 92.

Thanks to the variations in ecological conditions at various altitudes and the presence of irrigated lands, the flora of this region is comparatively varied. In general, comparatively slightly winter-resistant varieties of winter wheat and oats of the Mediterranean type are found.

81. Southwestern Highland Agroecological Region of the USA

374 In this region we include the areas of Arizona, New Mexico, Western Texas and Southeastern California, with a rather high elevation above sea level. The region is characterized by the comparatively limited rainfall, which decreases as we proceed westwards, where the climate becomes a desert and semi-desert one, within the borders of Arizona and Southeastern California. Whereas in the eastern areas of the region, agriculture is exclusively non-irrigated, in the western areas in Arizona and Southern California it becomes exclusively irrigated. In the South, there is a concentration of large-scale irrigated cotton farming, and spring and winter wheat and barley are also raised. The region is of comparatively limited importance for the cultivation of cereals. We present typical climatic data for the region in Table 93.

82. Southeastern Lowland Agroecological Region of the USA

In this region we place the states of Oklahoma and the adjacent areas of the state of Texas, Arkansas, Mississippi, Alabama, Georgia, South and North Carolina, West Virginia and Maryland. This region is characterized by a humid climate, particularly as we move westwards. The amount of rainfall in western areas reaches 1000 mm. The winters are mild, rain occurs in autumn, spring, and winter, i.e., the climate is similar to that of the Mediterranean. Cereal planting is carried out only in autumn. We present the climatic data in Table 94.

The region is characterized by Mediterranean oats, *A. byzantina*, which are resistant to smut and crown rust. Mediterranean soft wheat is also a standard type.

83. Mexican Highland Agroecological Region

In the pre-Columbian Period, the agricultural population of Mexico and all of Central America lived principally from the cultivation of corn, French beans, and pumpkin. The spread of cereals and leguminous seed crops of the Old World was a feature of the 17th-19th Centuries. At present wheat occupies 900,000 hectares and barley approximately 270,000 hectares.

We make no differentiation between various agricultural areas of Mexico constituting highly important focal points of original New World crops (American cotton, corn, French beans, etc) and characterized by a variety of conditions, and we only specify those territories here devoted to cultivation of true cereals and Old World leguminous seed crops. These are predominantly found in Mexico's northern highlands.

The climate of the Mexican northern highlands is close to the Mediterranean one. Rainfall occurs chiefly in autumn, spring and winter. It is only in the mountain areas, for example around Mexico City, that the distribution of rainfall differs from this. There the maximum is observed during the summer months. Summer is dry and winter comparatively mild. Unfavorable conditions for the growth of wheat are drought during the time of ear-formation and at maturation, and also frosts. Stem rust often has a destructive influence. It is precisely for this reason that the yields of wheat are here comparatively low, on the average below 6-7 centners per hectare.

The soil cover is represented predominantly by serozems (grey soils). The natural vegetation is that of the prairie steppe. Table 95 presents the climatic data for the region.



Mexico. Yucatan. Stone grinders preserved in villages near Chichen-Itza



Mexico. Yucatan, near Merifa. A Mai peasant with a tool for cutting plants



Mexico, Yucatan. Typical habitation near Chichen-Itza



Argentina, Santa Cruz. Flock of sheep

Table 93
Climatic data of the South-western Upland Agroecological Region of the USA

Place	Data	Month												Average
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Santa Fe, New Mexico 35°41' North lat. Elev. 2138 m	Precipitation(mm).....	17	20	20	25	31	27	59	57	38	29	17	17	367
	Av. temp. (°C).....	-2.1	0.3	4.1	8.3	13.3	18.4	20.3	19.4	15.9	10.1	3.4	-1.1	9.2
	Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-18.3
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-25.0
Amarillo, Texas 35°13' North lat. Elev. 1120 m	Precipitation(mm).....	13	19	18	47	70	73	71	77	59	41	23	20	591
	Av. temp. (°C).....	1.4	3.1	8.1	13.2	17.8	22.6	24.7	24.1	20.6	14.0	7.1	2.3	13.2
	Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-18.1
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-28.7
El Paso, Texas 31°47' North lat. Elev. 1155 m	Precipitation(mm).....	12	11	9	7	8	15	50	42	32	20	13	13	232
	Av. temp. (°C).....	6.9	9.3	13.1	17.4	21.9	26.4	27.1	26.1	23.2	17.3	11.2	6.9	17.2
	Av. abs. ann. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-10.2
	Abs. min. temp. (°C).....	-	-	-	-	-	-	-	-	-	-	-	-	-20.6

Table 94
Climatic data of the South-eastern Lowland Agroecological Region of the USA

Place	Data	Month												Average
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Birmingham, Alabama 33°32' North lat. Elev. 213 m	Precipitation(mm).....	137	138	142	124	98	115	129	106	87	60	85	129	1350
	Av. temp. (°C).....	7.1	8.7	12.7	17.1	21.4	25.1	26.2	25.7	23.4	17.9	11.9	7.8	17.1
	Av. abs. ann. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—11.2
Stillwater, Oklahoma 36°08' North lat. Elev. 268 m	Precipitation(mm).....	27	33	68	95	139	96	73	87	87	77	55	37	858
	Av. temp. (°C).....	—2.6	3.0	9.8	15.1	9.8	24.5	26.9	26.8	22.9	15.9	9.6	3.0	13.7
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—27.8
Ashville, North Carolina 35°36' North lat. Elev. 687 m	Precipitation(mm).....	78	86	99	78	85	101	107	104	78	69	58	80	1023
	Av. temp. (°C).....	3.4	3.9	8.4	12.4	16.8	20.7	22.3	21.9	19.3	13.3	7.8	4.4	12.9
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—21.1
Washington, D.C. 38°54' North lat.	Precipitation(mm).....	88	89	93	84	92	107	118	100	83	71	61	82	1068
	Av. temp. (°C).....	0.7	1.7	5.7	11.9	17.6	22.2	24.6	23.7	19.8	13.9	7.3	2.4	12.6
	Av. abs. ann. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—16.8
Columbia, Missouri 38°57' North lat. Elev. 237 m	Precipitation(mm).....	52	48	77	101	115	113	84	91	116	61	53	43	954
	Av. temp. (°C).....	—1.1	—0.6	6.4	12.5	18.0	23.0	25.0	24.4	20.5	14.0	6.8	0.7	12.5
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—35.3
Norfolk, Virginia 36°51' North lat. Elev. 28 m	Precipitation(mm).....	78	88	94	83	95	109	143	130	83	76	56	83	1118
	Av. temp. (°C).....	4.7	6.8	8.8	13.7	18.8	23.3	25.6	24.9	21.8	16.8	10.7	6.1	15.0
	Av. abs. ann. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—10.0
Savannah, Georgia 32°05' N. lat. Elev. 20 m.	Precipitation(mm).....	70	86	77	66	76	136	166	183	139	75	54	73	1201
	Av. temp. (°C).....	10.6	11.9	14.7	18.5	22.5	25.6	26.8	26.3	24.2	19.6	14.4	11.1	18.8
	Av. abs. ann. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—4.0

Table 95
Climatic data of the Upland Mexican Agroecological Region

Place	Data	Month												Σ T C V
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Casas Grandes, Mexico 30°25' North lat. Elev. 1478 m	{ Precipitation(mm).....	4	27	16	11	4	15	100	85	52	28	28	19	399
	{ Av. temp. (°C).....	8.5	10.7	12.8	15.5	20.4	25.4	25.5	24.0	22.0	16.8	11.4	7.6	16.7
	{ Av. abs. ann. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—8.2
Leone 21°11' North lat. Elev. 1809 m	{ Precipitation(mm).....	8	8	10	6	27	124	156	130	119	93	12	12	845
	{ Av. temp. (°C).....	14.0	15.8	18.6	21.4	23.2	22.0	20.7	20.6	19.9	18.2	16.1	14.2	18.7
	{ Av. abs. ann. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—0.3
Galiana, Mexico 30°08' North lat. Elev. 1654 m	{ Precipitation(mm).....	17	19	13	32	37	69	55	67	81	37	25	25	477
	{ Av. temp. (°C).....	12.5	14.0	16.3	19.3	21.2	21.0	21.1	20.4	20.1	18.1	15.7	13.8	17.8
	{ Av. abs. ann. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—4.8
San Luis Potosi, Mexico 22°09' North lat. Elev. 1877 m	{ Precipitation(mm).....	7	15	13	12	46	71	47	51	33	29	16	13	353
	{ Av. temp. (°C).....	12.6	14.5	17.0	20.1	21.6	20.9	19.8	19.8	18.5	17.1	14.5	12.7	17.4
	{ Av. abs. ann. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—0.5
Guadalajara, Mexico 22°41' North lat. Elev. 1583 m	{ Precipitation(mm).....	11	6	6	4	28	224	239	217	192	56	19	17	1009
	{ Av. temp. (°C).....	15.5	16.9	18.9	21.4	23.3	22.3	20.8	20.7	20.2	19.5	17.7	16.5	19.4
	{ Av. abs. ann. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—2.1
Pachuca, Mexico 20°08' North lat. Elev. 2438 m	{ Precipitation(mm).....	2	8	13	26	36	68	54	59	48	33	16	6	369
	{ Av. temp. (°C).....	11.8	13.0	14.8	16.3	17.1	16.3	15.1	15.7	14.9	13.9	12.9	12.1	14.5
	{ Av. abs. ann. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—0.5
Mexico City 19°26' North lat. Elev. 2282 m	{ Precipitation(mm).....	8	7	12	18	48	103	114	109	108	40	12	7	579
	{ Av. temp. (°C).....	12.4	14.1	16.2	17.4	18.4	17.7	16.7	16.8	16.3	15.1	13.9	2.6	14.8
	{ Av. abs. ann. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—0.9

The flora of types of the Mexican highlands is represented mainly by Mediterranean forms of wheat, barley, oats, and flax, introduced here after the Spanish conquest of the country. The types here are not standard. For the most part, crop communities were borrowed in the past from Spain, Italy, and other Mediterranean countries. Large amounts of soft wheats and barleys are grown. Just as in the Mediterranean countries, beans are widely grown. Chick-peas are represented by the Mediterranean large-seed forms. In general the flora of Old World crop types in Mexico is extremely close to the Mediterranean.

South America

In South America, Old World grain crops are grown chiefly in Argentina, Uruguay, Southern Brazil, Chile and mountain areas of Peru and Bolivia, where they were introduced by the Conquistadores in the 16th-17th centuries. The flora of wheat, barley, leguminous seed crops and flax varieties now found in South America has much in common with the types of Spain, Portugal and Mediterranean countries from which the first types were borrowed. Later the influence of the USA and other countries also made itself felt. Wheat has been subjected to the greatest changes and extensive selection work with this crop has been carried out in recent decades in Argentina, Uruguay and Chile, by means of hybridization.

Five agroecological regions may be distinguished from the point of view of the kind of conditions and the flora of types of the crops we are considering:

84. Areas of Argentinean Pampas in the proper sense of the word, including also the agricultural areas of Southern Uruguay.
85. Western and southern periphery of the Argentinian Pampas.
86. Southern steppe region of Brazil.
87. Irrigated areas of Chile.
88. High mountains of Peru and Bolivia.

The most important region in South America for the cultivation of cereals and flax is the pampas of Argentina, including also that part of Uruguay bordering on it from the north. Fields sown with Old World cereals here have totalled 13,000,000 hectares in recent years. Of the entire huge territory of Argentina, estimated at 279,000,000 hectares, 27,500,000 hectares are at present used for agriculture, the main area of sown fields being in the pampas. Areas under the various field crops borrowed from the Old World have at the present time in the fourth decade of the 20th century attained the following maximum values:

<u>Crops</u>	<u>Million of hectares</u>
Wheat	8.7
Lucerne	7.0
Flax	3.04
Oats	1.5
Barley	0.55
Rye	0.3
Leguminous seed crops	0.4

At the present time Argentina occupies the leading position in the world for the production of oil-flax, the area of which in recent years has attained 3,000,000 hectares. Argentina has also occupied the leading place for blue lucerne, which was borrowed from Europe. This crop takes up an area of nearly 7,000,000 hectares.



Argentina, Buenos Aires Province.
Fattening cattle on natural pastures



Argentina. Llama (guanaco)



Argentina. Cactuses in Andargala
(province of Katamarkh)



Argentina. Harvesting of wheat by combine.
on the Prairie Experimental Station



Argentina. Perennial plantation of Paraguayan tea (mate)



Uruguay. *Salix-Humboldtiana*.
in Montevideo park



Brazil. Spinning liana in tropical forest near Amazon River



Brazil. Coffee depot



Map 7. South America. Agricultural areas as of 1936. (Cultivated and fallow area, including gardens and vineyards). Each dot represents 250,000 hectares. Compiled by I.F. Makarov and I.V. Chekan; Edited by Acad. N.I. Vavilov.

84. Areas of the Argentinian Pampas Including Uruguay

A typical feature of the pampas, the distinctive South American steppe, is the chernozem soil, underlaid with limestone. The amount of rainfall in areas used for the cultivation of cereals and flax is about 800-1000 mm yearly. Cereal sowing is conducted from May to July, harvesting in December-January, remembering that the inversion of seasons is typical for the Southern Hemisphere, the coldest weather being in July and August and the hottest in December. Frosts occur in July and August. Delayed cold is also observed during the time of ear formation. The climatic data are presented in Table 96. Potato and sugar beets grow poorly. Cereals sown in cold periods are the most successful crop. Rainfall decreases as we progress towards the desert areas of the Argentine hinterland in the direction of the Cordilleras. Since there is sufficient humidity, leaf rust is widespread here both on wheats and oats. The soils are chernozems (black soils) and chestnut soils. Typical is the natural vegetation found in the prairies (steppes), as the result of the extensive character of agricultural practices, the average wheat yield of Argentina is not high, being given for the 1925-1933 period as 8.0 centners per hectare*.

As a result of modern selection by hybridization methods, very valuable types of wheat have been raised which resist lodging and shattering, and are rust-resistant. This work made use of both ancient western Mediterranean types of soft wheat and steppe types, introduced from the USA, and in part also Chinese types. One of the prominent types is 38-MA, developed by Backhouse by crossing the European soft wheat Bartlet variety with Chinese wheat resistant to yellow rust. Recent years, as the result of the extensive employment of combines, have seen special attention being paid to raising wheat varieties with a sturdy straw and non-shattering grains. In this respect, an exceptional role has been played by ancient types of wheat distinguished by a well-filled straw.

According to the latest survey of the geographical distribution of wheat types carried out by the Ministry of Agriculture in the Argentine, the pampas are classified into the following areas:

The northern zone, adjoining Uruguay, where the standard wheat types are the 38-MA (figure 166), Sin-rival, Klein 32, and San Martin.

Cordova to Pirgamin. Here the characteristic types are Vencidore, Sin-rival, Klein 33, Klein 32.

Zone adjacent to Parana River and bordering Uruguay. Recommended types are Lin-Kalel, 38-MA, Sinmark, Vencidore.

Hinterland Argentine, the types of which are Lin-Kalel and Kanred (winter).

The most frequently encountered variety in the Argentine until recently has been 38-MA, followed by Lin-Kalel, Vencidore and Sin-Rival. Lately types developed by Klein have begun to spread, Nos. 32 and 33. In Uruguay, the Articos type, developed by means of hybridization by Berg in the Colonia Experimental Station has made particular progress, being distinguished by high productivity and good flour-milling and bread-baking qualities.

In the Argentine old bearded types similar to Rieti are also grown.

Both Argentinian and Uruguayan types of wheat grow as either spring or semi-winter types when placed under the conditions of our steppe, forest-steppe and forest zones.

* See: N.I. Vavilov. Wheats of the USSR and Abroad. Collection "Wheat Cultivation". Material from the Second Session of the All-Union Lenin Academy of Agricultural Sciences, Moscow, 1936.



Brazil. Typical habitations of poor peasants of the Amazon area



Southern Brazil. Tilling cotton fields after clearing away tropical forest



Bolivia. Snow-cap of Illimani mountain, 6447 metres above sea level. In foreground are eucalyptus.



Brazil. At the Bazaar in Belem (Para), Cucurbita moshata and bananas.



Bolivia. Indian with llama



Bolivia. Sorting potatoes



Bolivia. Preparation of chuno in progress



Bolivia. Preparing chuno from potatoes

Table 96
Climatic data of the Argentinian Pampas Region

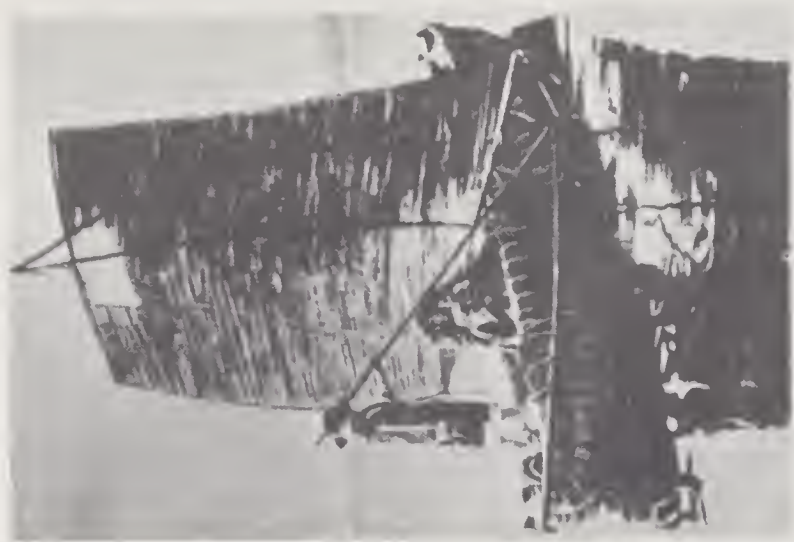
Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Santa Fe 31°40' South lat. Elev. 26 m	{ Precipitation(mm).....	94	103	104	132	56	34	37	27	53	83	114	120	957
	{ Av. temp. (°C).....	24.9	24.2	22.1	18.8	15.1	12.0	11.6	12.4	15.3	18.1	20.9	23.4	18.2
Montevideo 34°55' South lat.	{ Precipitation(mm).....	67	78	81	116	87	82	62	90	86	64	92	90	985
	{ Av. temp. (°C).....	22.2	22.1	20.3	17.2	13.7	10.7	10.3	10.7	12.7	14.5	18.1	20.8	16.1
Mecedes, Uruguay (average for 10 years) 33°15' South lat. Elev. 39 m	{ Precipitation(mm).....	88	52	73	101	61	61	55	66	59	100	62	90	868
	{ Av. temp. (°C).....	24.1	23.6	22.2	17.2	13.0	10.0	10.4	12.0	13.8	16.6	20.3	22.1	17.1
Parana, Argentina 31°44' South lat. Elev. 65 m	{ Precipitation(mm).....	81	81	98	140	49	32	37	29	51	77	102	100	877
	{ Av. temp. (°C).....	25.1	24.7	22.9	18.8	15.6	11.8	12.4	13.7	16.0	18.4	21.7	24.3	18.8
Rosario, Argentina 32°57' South lat. Elev. 30 m	{ Precipitation(mm).....	75	75	86	112	44	31	35	34	57	95	109	99	852
	{ Av. temp. (°C).....	24.8	24.0	21.8	18.3	14.6	11.1	11.0	12.0	14.8	17.5	20.5	23.3	17.8
Buenos Aires 34°30' South lat.	{ Precipitation(mm).....	78	71	98	122	71	52	54	56	74	85	101	102	964
	{ Av. temp. (°C).....	23.1	22.5	20.4	16.3	12.8	9.8	9.4	10.6	12.8	15.5	18.8	21.6	16.1



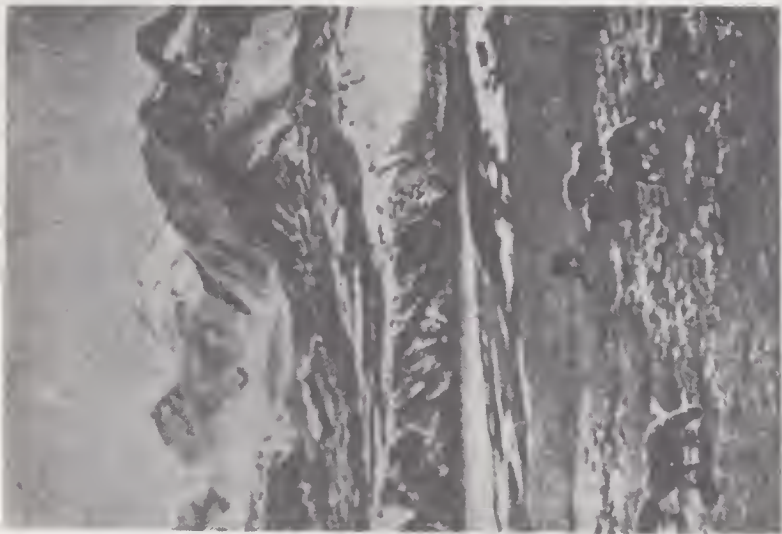
Bolivia. Construction of reed boats on Lake Titicaca



Bolivia. On Lake Titicaca



Bolivia. On Lake Titicaca



Bolivia. Near Lake Titicaca

397



Peru. Primitive agricultural implements of inhabitants of Hualato, Peru



Bolivia. Province of Yungas.
Quinine tree (Cinchona)



Peru. Indian hut, Choza



Peru. Llamas in environs of town of Kusco

All of Argentina, as well as the whole of Uruguay, is characterized by the widespread growth of Mediterranean oats, A. byzantina, resistant to smut and rust.

The flax of Argentina and Uruguay is represented by two types. One of them, the most widespread, has seeds, bolls and flowers of average dimensions and low height — Linetta. The other is the typical Mediterranean flax with large seeds, bolls and flowers — Lino grande. Both were introduced from the Mediterranean countries, the first apparently from Italy. Under our normal conditions of flax sowing, both are distinguished by rust resistance and are also weakly affected by Poly-*spora* and Colletotrichum. The oil yield attains 42%. The Uruguayan Experimental Station has raised types of flax with particularly high oil yields.

We here meet mainly four-sided barley; two-rowed brewing barley is more rarely encountered. Leguminous seed crops are represented by typical Mediterranean large seed forms, apparently borrowed from Spain (Andalusia and Valencia). Large-seed types of chick-pea (garbanzo) are sown, with a white color and large seed beans. Occasionally plate-form lentils are cultivated.

85. Western and Southern Periphery of the Argentinian Pampas

The Western and Southern Periphery of the Argentinian pampas is characterized by more severe conditions. Rainfall drops sharply as we approach the semi-desert areas adjacent to the Cordilleras and south thereof. One of the unfavorable factors for agriculture in the South is the outcropping on the surface of bedrock limestone formations, as a result of which the soils are shallow and above all quite unfit for the cultivation of lucerne. The western periphery of the pampas is elevated. The characteristic climatic data for the region are presented in Table 97.

The flora of crops and types changes as we proceed from the center to the periphery of the pampas. Here large quantities of rye and barley are grown. The yields are considerably lower than in the main portion of the pampas. The standard types of wheat for the southeastern part of Argentina are considered to be Quadrage, Lin-Kalel, Kanred, Sinmark. For the southern areas, in the direction of Patagonia, the standard types are at present Kanred from the USA, Lin-Kalel, and 38-MA. Oats are represented by Mediterranean forms. Recently a great deal of work has been carried out by the selector Williams for the development of new hybrids of wheat and rye. The hybrids obtained are fertile, but are not widespread. They are characterized by their non-shattering habit, the compact enclosure of grains within the bracts, and strong straw. As far as ecological demands are concerned, these hybrids occupy as it were, an intermediate position between rye and wheat. But their productivity is considerably lower than that of wheat.

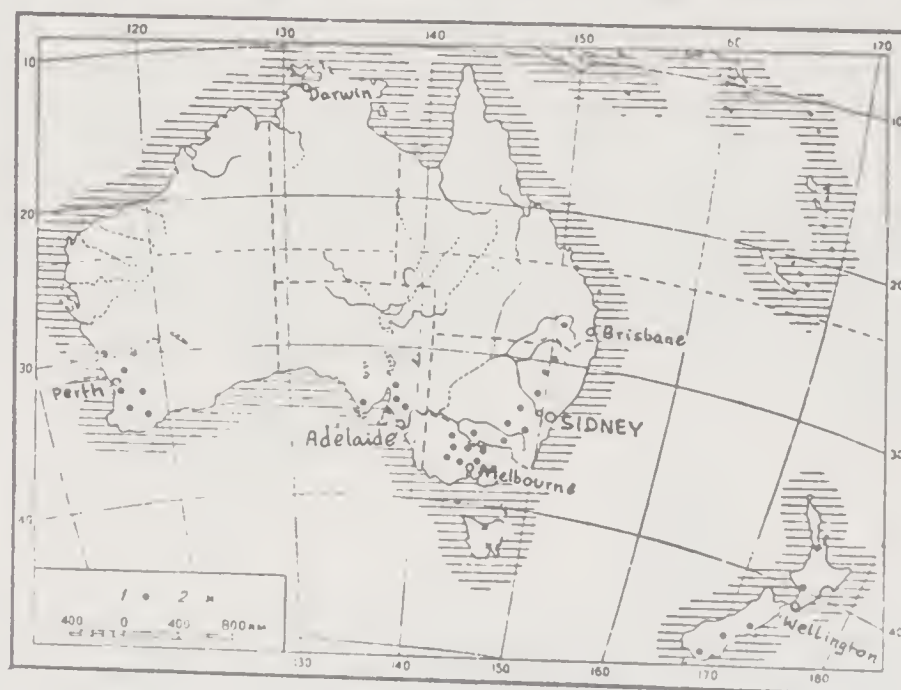
In the Tecuman area, wheat is grown on irrigated lands. Of particular interest is the type Alto De Sierra, which under irrigation produces high-quality grain from the point of view of bread-baking qualities.

86. Brazil—Southern Steppe Region

Of the vast territory of Brazil, calculated at 851,000,000 hectares, agriculture at the present time takes up less than 7,000,000 hectares, which is about 0.8% of the entire area of the country. Forests occupy 500,000,000 hectares, or 58.8% of the territory. Approximately half of the cultivated lands are under plantation of the coffee bush and cocoa, Theobroma cacao L., and the sugar cane (Saccharum officinarum L.). The cultivation of cereals is concentrated chiefly in the southern areas in the state of Rio Grande du Sol, Paran, and Santa Catarina. Until



FIGURE 166. Common wheat—*Triticum vulgare*
Vill. Variety 38-MA, Argentina



Map 8. Australia. Agricultural areas as of 1936.
(Cultivated non-fallow area, including gardens
and vineyards). Each dot represents 250,000
hectares. Each x represents 50,000 hectares.
Compiled by I. F. Makarov and I. V. Chekan;
Edited by Acad. N. I. Vavilov

not long ago, these states, which are represented in the South by rich prairies, were mainly devoted to cattle raising. In recent decades, particularly in Rio Grande du Sol, fields sown with wheat, barley, leguminous seed crops and especially corn, have begun to spread. The area under these has reached 100,000,000 hectares. Under barley are 15,000,000 hectares, under rye 17,000,000 hectares, and under oats 15,000,000 hectares (1932-1936).

We present typical climatic data for the region in Table 98.

In climate these areas are similar to Northeastern Argentina, distinguished by a larger amount of rainfall. Cereals here suffer from the surplus of rain and fogs and high temperatures, which favor the development of rust. The excessive rainfall favors the intensified development of the vegetative organs.

Selection work began very recently. The basic trend in wheat selection in Brazil has been the development of types resistant to rust and capable of enduring excess warmth. For today, mainly old assortments of Argentine are used, such as the Reiti type, which is rust-resistant, and Barleta Americana, often called Trigo Argentine, i.e., Argentinian wheat. Satisfactory results have been given by the Italian types of Maiorca and Timilla. Only soft wheats are grown here. Sowing commences in June-July and harvesting in November-December. Leguminous seed crop varieties, principally beans and chick pea, are represented by the typical large seed Mediterranean forms.

87. Irrigated Areas of Chile

The agricultural areas of Chile are mostly concentrated in the central and southern parts of the country. The very elongated character of the country, its location at the foot of the Cordilleras, and partly in mountain and foothill areas, are responsible for the variety of conditions. From the desert of Atakam, which has no rainfall and where the world's deposits of nitre are concentrated, the amount of rainfall increases as we proceed south. The abundance of mountain waters supplied from the Cordilleras favors the development of irrigated agriculture. In the central, 401 drier areas, irrigation is usually practiced on a large scale for both vegetables and garden cultivation and lucerne and wheat. The southern areas around Temuko are characterized by a sufficient quantity of rainfall. The cultivation of cereals is here non-irrigated. The central areas around Santiago have climatic conditions resembling those of Mediterranean countries. Accordingly the flora of crops and types has to a considerable measure been borrowed from the Mediterranean, which is seen with particular distinction in the flora of leguminous seed crops, wheats and oats. Chile's central areas have climatic conditions like Andalusia and Valencia. Of the total area of the country, amounting to 16,300,000 hectares, in 1932-1936 the different crops occupied some 1.2 million hectares. Of these the following figures are illustrative:

	<u>Thousand hectares</u>
Wheat	62.5
Oats	92
Barley	81
Flax	2.1

The climatic data are presented in Table 99. In recent years the selection stations in Santiago and Temuko have evolved a series of types of wheat now widely spread in cultivation. Thanks to the variety of conditions, the flora of Chilean types is comparatively varied, consisting of hard, soft and club wheats. Beardless soft wheats are the main ones cultivated. The Ministry of Agriculture of Chile has proposed a number of foreign and Chilean wheat types for reproduction in various areas (1936-1937).

Table 97
Climatic data for the Western and southern periphery of the Argentinian Pampas

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Baia Blanca 38°45' South lat. Elev. 25 m	{ Precipitation.....	55	61	56	89	28	16	23	18	43	62	47	51	549
	{ Av. temp. (°C).....	23.6	22.0	19.7	15.6	11.7	8.4	8.0	9.4	12.0	15.1	19.1	22.1	15.6
Cordoba 31°35' South lat. Elev. 423 m	{ Precipitation.....	96	128	81	54	27	6	14	15	24	67	102	116	719
	{ Av. temp. (°C).....	23.3	22.4	20.3	16.7	13.2	9.8	10.3	11.9	14.8	17.4	20.2	22.3	16.9
Tucuman 26°51' South lat. Elev. 450 m	{ Precipitation.....	160	190	139	79	30	14	4	13	15	59	107	151	965
	{ Av. temp. (°C).....	24.9	23.7	22.0	19.1	15.5	12.0	12.0	13.8	17.9	20.5	22.6	23.9	19.0

Table 98
Climatic data of the South Brazil Steppes

Place	Data	Month												Year
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Curitiba (Parana) 25°25' South lat. Elev. 908 m	{ Precipitation(mm).....	168	159	112	79	102	102	64	81	124	140	128	139	1398
	{ Av. temp. (°C).....	20.4	21.1	19.3	16.8	13.7	12.2	12.5	13.5	14.6	16.1	18.0	19.6	16.5
	{ Av. abs. ann. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—1.7
Blumenai, Santa Catarina (average for 6 years) 26°55' South lat. Elev. 15 m	{ Precipitation(mm).....	200	283	165	98	60	105	51	98	120	99	76	122	1477
	{ Av. temp. (°C).....	24.4	24.2	22.5	21.4	18.3	15.1	14.6	15.9	17.7	19.6	21.4	23.1	19.8
	{ Av. abs. ann. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—1.0
Curitibanos, Santa Catarina (average data for 8 years) 27°17' South lat. Elev. 908 m	{ Precipitation(mm).....	170	155	150	106	83	184	110	115	202	138	114	134	1661
	{ Av. temp. (°C).....	19.8	19.2	18.1	16.2	13.4	11.6	11.5	11.7	13.6	15.2	17.1	18.3	15.5
	{ Av. abs. ann. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—1.3
Uruguaiana, Rio Grande 29°45' South lat. Elev. 76 m	{ Precipitation(mm).....	95	100	175	148	115	128	72	76	99	96	93	111	1308
	{ Av. temp. (°C).....	26.0	25.2	22.8	20.3	17.0	12.7	13.6	13.9	16.3	18.8	21.9	24.5	19.4
	{ Av. abs. ann. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—
Santa Maria (Rio Grande) (av. data for 10 years) 29°45' South lat. Elev. 139 m	{ Precipitation(mm).....	160	150	136	133	169	172	138	140	169	100	131	139	1727
	{ Av. temp. (°C).....	24.9	24.4	22.2	20.0	17.3	13.4	14.1	14.3	16.4	18.5	21.2	23.7	19.2
	{ Av. abs. ann. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—
Porto Alegre, Rio Grande 30°02' South lat. Elev. 15 m	{ Precipitation(mm).....	109	94	91	121	103	124	108	129	116	80	88	104	1266
	{ Av. temp. (°C).....	24.5	24.7	22.7	20.5	17.2	13.5	13.6	14.6	16.5	18.4	21.2	23.2	19.4
	{ Av. abs. ann. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—1.3

Table 98 (continued)

Rio Grande 32°02' South lat. Elev. 2 m	{ Precipitation(mm).....		88	145	90	77	82	115	192	91	121	85	86	73	1185
	{ Av. temp. (°C).....		22.9	23.4	21.8	19.8	16.9	12.8	12.7	13.5	15.1	16.8	19.7	21.8	18.1
Santa Vitoria du Palmar 33°32' South lat. Elev. 5 m	{ Precipitation(mm).....		94	180	122	100	110	106	104	116	124	90	75	90	1259
	{ Av. temp. (°C).....		21.9	22.1	20.3	18.3	15.3	11.2	12.4	11.9	19.5	15.3	18.1	20.5	16.7

Table 99
Climatic data of the Agricultural Areas of Chile:

Place	Data	Month												T E M P	
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
Valparaiso 33°01' South lat. Elev. 41 m	{ Precipitation(mm).....	0	0	9	14	97	145	101	66	38	11	7	4	492	
	{ Av. temp. (°C).....	17.6	17.3	16.3	14.5	13.1	11.3	11.3	11.7	12.3	13.7	15.6	16.9	14.3	
	{ Av. abs. ann. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—3.6	
Santiago 33°37' South lat. Elev. 520 m	{ Precipitation(mm).....	1	2	5	14	60	84	72	53	33	13	6	5	348	
	{ Av. temp. (°C).....	20.4	19.5	16.9	13.7	10.6	7.6	7.9	9.2	11.0	13.8	16.8	19.2	15.9	
	{ Av. abs. ann. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—2.7	
Temuco 38°45' South lat. Elev. 110 m	{ Precipitation(mm).....	30	45	83	141	227	178	171	158	86	61	72	54	1306	
	{ Av. temp. (°C).....	16.6	16.0	14.4	11.9	9.8	7.3	6.8	7.8	9.3	11.3	12.9	15.0	11.6	
	{ Av. abs. ann. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—2.9	
Valdivya 39°48' South lat. Elev. 9 m	{ Precipitation(mm).....	61	76	141	239	387	433	409	336	220	132	127	105	2666	
	{ Av. temp. (°C).....	16.6	15.8	14.4	11.7	9.8	7.5	7.6	8.0	8.9	11.1	12.3	15.0	11.6	
	{ Av. abs. ann. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—2.5	
Puerto Montt 41°28' South lat. Elev. 10 m	{ Precipitation(mm).....	117	113	150	189	270	253	275	236	161	140	140	138	2182	
	{ Av. temp. (°C).....	15.3	14.5	13.3	11.3	9.8	7.7	7.7	7.8	8.5	10.6	12.0	13.9	11.0	
	{ Av. abs. ann. min. temp. (°C)	—	—	—	—	—	—	—	—	—	—	—	—	—1.8	

For the southern areas, adjacent to Valdivia, Temuco, and Lake Shiloe, situated between 35-45° south latitude, the greatest variety of types is recommended:

1. Baron, soft beardless, bred in Italy by plant-breeder Strampelli by means of individual selection.
2. Vilmorin 23, developed in France by the firm of Vilmorin (soft beardless of the Dickkopf type).
3. Grune Dama (Senora verde), an old German type (soft beardless).
4. Vienna, developed by Tschermak in Austria. Soft bearded.
5. Prima vera, old type of soft beardless wheat.
6. Temuco, developed from the Italian Ardito type.
7. Lucia, raised by individual selection in Italy by Strampelli.
8. Marquis or Manitoba, the well-known Canadian hybrid.
9. General San Martin—German type, developed by Struba by means of continuous individual selection (of the Dickkopf type).

For the Central Plains of Santiago, the following are recommended:

1. Of the hard wheats, Candéal and Capelli, bred by the Italian, Capelli, by means of individual selection.
2. The soft beardless wheat variety Ideal pelon, obtained by means of crossing Uruguay with Barleta italiana.
3. The Caupeliean variety, bred by the Santiago Selection Station by means of individual selection. Beardless soft.
4. Marquis.
5. Florida (hybrid between Australian-Florence and Chufquen).
6. Lucia. Soft Beardless. Bred by Strampelli in Italy.
7. Vienna. Austrian type. Bred by Tschermak.

For the more northerly areas, to the north of Valparaíso, in the direction of Coquimbo, the recommended types are Lotharo, bearded-soft, raised by means of individual continuous selection in the Argentine by the Selector Klein, and also Lino-coyan, obtained from an Indian type by the method of continuous individual selection—a typical Indian type with short beards.

Finally, the Colorado barbudo type, one of the old types of soft bearded wheat developed by individual selection, is recommended for all areas.

In addition, in the area of Temuco, dwarf types resistant to excess rainfall are grown from time to time.

Sowing of wheat commences in Chile from March to June, depending on the region.

On the whole, around 300,000 hectares of soft wheat and about 20,000 hectares of hard wheat are cultivated in Chile.

As far as the time of harvesting is concerned, it varies depending on the conditions of irrigated and non-irrigated farming. In the irrigated lands to the south, harvesting is conducted from December to March, and in the non-irrigated lands, from December to February. To the north of Valparaíso cereal harvesting is conducted on non-irrigated lands from November to December and on irrigated lands from December to January.

88. High Mountains of Peru and Bolivia

In the Pre-Columbian period, the agricultural population of the foothill areas

of Peru and partly of the mountain areas of Bolivia, as has already been noted, lived principally on the cultivation of corn, French beans, and pumpkins. The peasants of the Altiplano and the Puna (mountainous steppes) chiefly grew pigweed (quinoa, *Chenopodium quinoa* Willd.) the potato, (*Solanum L.*), the ulluco potato substitute (*Ullucus tuberosus caldas*), the "anu" (*Tropaeloum tuberosum* Ruiz. et. Pav.), and other endemic tubers. An important role, today as in the past, is played by the fact that the Indians bred local endemic animals — the llama (*Llama huanaco* var. *glama*) and the alpaca (*Llama huanaco* var. *paca*), whose native habitat is the South American Andes. At the present time, cereals introduced in the 17th century from the Old World are grown in Bolivia and Peru, chiefly in the mountain areas at a height of 1500 and 4000 meters. Even the capital of Bolivia, La Paz, near which are located considerable agricultural concentrations, is situated at a height of 3600 meters. The cultivation of barley rises at Potosi to heights of 4040 meters. Of the entire territory of Peru, estimated at 187,000,000 hectares, cultivated plants at present occupy approximately 1.5 million hectares*.

Of these, we have:

<u>Under</u>	<u>Approximately (1000 hectares)</u>
Wheat	145
Barleys	125
Beans	67
Lentils, chick peas	<u>7</u>
TOTAL	344

Fields sown with wheat in Peru are concentrated principally in the Departments of Ankash (28,000 hectares), Cajamarca (28,000 hectares), Cusco (21,000 hectares), Huancavelica (13,000), Junin (15,000), Puno (21,400). The great majority of beans is grown in Cajamarca (42,000 hectares). A large part of the fields sown with chick peas (garbanzo) and lentils is concentrated in the Department of Cajamarca (2.3 thousand hectares), Lambayeque, and Piura (4.2 thousand).

Of the entire territory of Bolivia, which is estimated as 157 million hectares, cultivated crops occupy at the present time about 2 million hectares. The fields are concentrated principally in the mountain areas between 1800-2700 meters. Around 200,000 hectares are occupied by wheat, barley, and leguminous seed crops. Barley is grown for both forage and beer-brewing. Wheat, barley, and the potato are cultivated mainly without irrigation.

The high mountain areas of Peru and Bolivia — altiplano — and the mountain pampas are characterized by adequate rainfall. In Puna, over the growing period — from October to March — there falls on the average around 1000 mm. In Juancayo 890 mm, in Cajamarca 1125 mm, and in Cerro de Pasco 875 mm. In the lowland areas, as we approach the coastal desert zone where the capital of Peru, Lima is located, the amount of rainfall falls to nil, rains here being replaced by fogs, and cultivation being possible only by means of irrigation. Climatic data for the region are presented in Table 100.

Sowing takes place at different times in the various zones. In Peru, in the Ariquipa, in June and July; in the Puna zone in the high mountain steppe area of Peru and Bolivia, in September-October; in Cusco, in October.

The growing season is prolonged. Harvesting is carried out in Cusco in the first half of June, in Ariquipa in November-December.

In the high mountain areas, wheat suffers from frost, in Puna, near Lake

* Estadística general agro-pecuaria del Peru. Ministerio de Fomento Dirección de Agricultura y Genederai, Lima, 1932.

Table 100

Climatic data of the high mountains of Peru and Bolivia

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
La Paz, Bolivia (av. data for 7 years) 16°30' South lat. Elev. 3658 m	Precipitation (mm).....	96	124	65	38	12	2	4	27	20	32	40	107	567
	Av. temp. (°C).....	10.2	10.2	10.0	9.1	8.7	7.1	6.4	7.9	9.6	10.0	11.0	10.8	9.3
Cochabamba, Bolivia (av. data for 3 years) 17°23' South lat. Elev. 2575 m	Precipitation (mm).....	105	96	62	11	11	7	5	4	17	15	32	99	464
	Av. temp. (°C).....	13.8	18.5	17.3	16.9	15.6	14.0	15.3	16.3	17.7	19.7	20.0	19.0	17.4
Sucre, Bolivia (av. data for 8 years) 19°03' South lat. Elev. 2850 m	Precipitation (mm).....	138	128	93	46	7	2	4	4	20	35	62	62	621
	Av. temp. (°C).....	12.6	12.6	13.6	12.8	13.4	10.0	9.7	11.5	13.1	13.3	14.5	14.0	12.4
Cajamarca, Peru (av. data for 4 years) 6°47' South lat. Elev. 2810 m	Precipitation (mm).....	132	234	210	93	40	17	11	5	62	119	68	141	1132
	Av. temp. (°C).....	14.7	15.4	15.8	15.2	14.1	11.9	13.2	13.8	14.1	14.8	15.4	15.9	14.6
Cerro de Pasco, Peru (av. data for 4 years) 10°43' South lat. Elev. 4350 m	Precipitation (mm).....	117	114	91	86	58	23	28	31	70	85	87	94	884
	Av. temp. (°C).....	6.7	6.2	6.7	6.7	5.9	5.0	4.7	4.9	5.0	5.4	5.7	5.8	5.7
Puno, Peru (av. data for 2 years) 15°50' South lat. Elev. 3822 m	Precipitation (mm).....	193	206	124	88	24	0	11	22	46	127	59	73	973
	Av. temp. (°C).....	9.0	8.5	9.1	8.8	7.6	6.3	5.8	7.1	8.0	9.4	10.3	10.1	8.3

Table 100 (continued)

Cusco, Peru (av. data for 5 years) 13°30' South lat. Elev. 3380 m	{ Precipitation (mm)..... Av. temp. (°C).....	162	149	110	51	14	6	4	11	25	67	75	136	809
		11.4	11.2	11.1	18.8	10.3	9.1	8.9	9.9	11.9	11.6	12.1	11.2	11.4
Ariekipa, Peru 16°22' South lat. Elev. 2451 m	{ Precipitation (mm)..... Av. temp. (°C).....	30	46	15	4	1	0	1	0	0	1	1	9	108
		19.9	19.9	19.5	14.1	19.8	19.2	19.1	19.8	14.4	19.6	19.9	14.1	19.8

408 Titicaca (Bolivia), at a height of 3800-4000 meters, barley is often harvested while green, since it has not had time to mature.

In the littoral areas, where there is a concentration of exclusively irrigated cultivation, wheat, as a result of dense fogs, suffers greatly from stem rust.

The types of cereals of Peru and Bolivia are borrowed from Europe, mainly from Spain. In general, the types grown up to now have been mainly those introduced from the time of the Conquistadores. Selection work with wheat began only very recently. Hard wheat is represented mainly by the type Candeal. Of the soft wheats in Peru, we find the bearded Huanne negro and Huanne blanco. In addition, in certain areas, Canadian types, Marquis and Red Fife, grow satisfactorily. Soft wheats are concentrated mainly in the mountain areas, while hard wheat is cultivated in the lower-lying areas.

The types of leguminous seed crops are borrowed from Spain (Andalusia and Valencia) and are represented chiefly by large-seed forms.

Australia and New Zealand

The agricultural areas of the Australian continent are principally concentrated in the Southeast and Southwest. The interior part of the continent constitutes a sterile desert. The northern areas of Australia belong to the humid tropical zone and have so far been used but little for agricultural purposes.

In the not distant past, before the arrival of Europeans, as recently as the middle of the eighteenth century, Australia knew nothing of agriculture. The rich wild flora of Australia is characterized by unique wood and grass vegetation. Botanists have established not less than 10,000 species, of which 86% are endemic. It is in Australia that we may trace the origins of large numbers of Eucalyptus species, as well as hundreds of species of myrtle and acacias, and 25 species of cassowary. Australia however, gave no food plants suitable for cultivation to the world.

Although the first wheat and other cereal farming took place in Australia as early as the end of the eighteenth century, on the whole the development of agriculture belongs chiefly to the second half of the 18th century. The export of wheat from Australia started in 1898. From then on, the areas under cereals increased quickly. By 1940, the sown area in Australia under all crops totalled 9.5 million hectares, corresponding approximately to 1.2% of the entire territory of the Australian continent (774.4 million hectares).

The main concentrations of agriculture are found in the states of Victoria (8.6% of the entire area), New South Wales (2.5%), in Southern Australia (1.5%), and in Tasmania (1.5%). According to calculations of Australian agronomists, there still exist within the boundaries of Australia huge possibilities for extending wheat cultivation. The total area of lands suitable for raising wheat is estimated at 130 million hectares*. The total area sown with wheat in 1935 amounted to 5.1 million hectares, corresponding to some 56% of the entire cultivated area. A small quantity of wheat (about 3%) is grown for green fodder and hay.

Fields sown with wheat occupy a zone stretching parallel to the coast from the south of Queensland along the Western and South-western slopes of the highlands of New South Wales, through the northern part of the state of Victoria in the direction of Southern Australia, where the fields come right up to the coastal strip. In general,

* Encyclopaedia Britannica, Vol II, 14th Edition.

wheat is here cultivated at a certain distance from the coastal strip. The coastal strip, which is more humid, is used chiefly for pasturage, meadows and forage agriculture. In addition, wheat is concentrated in Western Australia in a southeast to northwest direction.

409 The sowing of wheat, barley, and oats occurs around winter, at the beginning of the low temperature period, when the rainy period begins. Sowing usually begins from the second half of April, continues in May and is concluded in June. Harvesting occurs in November-December. The rainy season occupies the April-October period. The amount of rain varies in the wheat areas from 250 to 600 mm. The lowest quantity of rainfall is characteristic of the northern areas adjacent to the desert and the heaviest rainfall occurs in the southern areas adjoining the coastal strip.

The average yield of wheat in Australia, as the result of the pernicious action of drought and fungal diseases, is not high, fluctuating on an average over the decades (1915-1924) and (1925-1933) from 8.4 - 7.6 centners per hectare).

The development and extension of the cultivation of wheat in Australia is connected mainly with successes achieved with the selection and mechanization of agriculture. The beginning of scientific selection in Australia was in 1886, when Farrer began to carry it out for the first time. Up to Farrer, late-maturing types imported by the first settlers from England were the types mainly grown in Australia.

410 Farrer became convinced that already prepared foreign types, even coming from countries with similar climates, did not entirely suit conditions in Australia, and he proceeded to change radically the types of wheat by means of hybridization, enlisting for this purpose a special large collection from various areas with more severe conditions. He directed his attention principally to such properties as speed of maturation, resistance to stem rust and smut, and quality of grain. In order to bestow quickness of maturation to the Australian types, Farrer used early Indian and South African wheats. For improvement of grain quality he employed the Fife type of Canada. To combine speed of maturation and high quality of grain with productivity he crossed Indian and Canadian types with the old European type Purplestraw. The first wonderful result of this triple combination was the Federation type evolved in 1901. This type possessed a high degree of plasticity and shortly occupied large areas of the country. By 1925 Federation had become one of the most widespread types. Of other types developed by Farrer, we may mention Florence, Raimer, Comeback, Bunyip, Cleveland, Thew, and Clarendon.

By the use of South African types, a fast-maturing and drought-resistant type (Firbank) was created by a cross between Zealand wheat with fast-maturing types of Maffra of South Africa.

The Florence type, evolved by Farrer by complex hybridization, is distinguished by resistance to stinking smut and also in a considerable measure to stem rust, and to this day is the leading type in Queensland*.

The work begun by Farrer was successfully continued by the Australian selectors**.

* See: N.I. Vavilov, The Scientific Basis of the Selection of Wheat, Leningrad, 1935. The genealogy of many Australian wheats is traced here.

** H. Wenholz, The Improvement of Australian Wheat, Department of Agriculture, New South Wales, Sydney, 1937.



Australia. Reclaiming hills of valley under perennial plantations of citrus and other crops



Australia. Eucalyptus



Australia. View of valley
with cultivated areas



Australia. Citrus plantations

Just as Farrer had done, other Australian selectors used fast-maturing South African types to a considerable extent, for instance, Steinwedel and Early Baart, known also by the name of Du Toit, which proved to be even more valuable components for crossing than Indian early types had been. With the Early Baart type, the method of individual selection was used to produce Ward's Prolific, which is rust-resistant, and from the latter, Barooto Wonder and Gluyas Early, types which have not lost their importance to this day.

The selector Marshall crossed Ward's Prolific with Purplestraw and obtained an excellent type, Marshall's 3. This type is to this day grown in New South Wales. By means of the further crossing of a line selected from Marshall's 3, to be precise, Silver King (with a light-colored straw), with Farrer's hybrid Fife x Indian called Yandilla, Marshall in 1907 obtained the type Yandilla King. Yandilla, as pointed out above, had already been used by Farrer to create Federation. Yandilla to this day is considered one of the best types for productivity and speed of maturation and is grown particularly in New South Wales. The selector Rue in 1912 produced for the State of Victoria the type Currawa by crossing Triticum compactum and Triticum durum. From these parents of Currawa he acquired comparative resistance to drought and rust. The same selector evolved the Mayer type by crossing the hybrid Wallace type (Fife x Indian x Purple Straw with Federation).

The selectors Pridham and Hurst evolved a productive type, Canberra (1914,. The genealogy of this type is highly dubious. The Federation type was taken as one of the parents. Volga barley is supposed to have been used as the second parent, which hardly sounds plausible. There is an assumption, probably truer, that this is a hard and soft wheat hybrid. The type is strongly affected by stem rust and loose smut, and despite its high productivity is raised at the present time only on some tens of thousands of hectares.

It found much greater employment in Greece, where it maintained one of the leading positions for yield.

In 1914, the same selector Pridham used Federation to evolve Hard Federation, apparently a natural hybrid distinguished by the high quality of its grain and its productivity but with the defect that it is susceptible to smut and stem rust.

Pridham also evolved the type Clarendon from crossing the types Bobs, Gluyas and Jonathan, used particularly for the cultivation of green forage. This was the best type in Australia for green forage.

We note the type Ford, developed by Scott for southern Australia. With complex genealogy, including in its initial types Steinwedel (South Africa), Comeback and Zealandia. Ford excels all Australian types in resistance to stem rust and at the present time occupies a large area — nearly 80% of the entire area under wheat, being particularly widely grown in Southern Australia.

For Western Australia, the farmers Harper and Gresley developed the hybrid Gresley by crossing the beardless hybrid Hugenot, which has a high thin straw (Triticum durum x Triticum vulgare) with Federation, which has a comparatively short straw. Gresley is used for grain and also for green fodder. Although it did not originate from the cross of soft wheat with hard, its principal defect is susceptibility to stem rust.

First place in Australia for area under cultivation is taken by the type Nabava

(Figure 167), raised by Sutton in 1915. This type traces its origin from the cross of the types Gluyas Early and Bunyip. Gluyas Early, which was bred by the Australian selector Gluyas from a South African type, is distinguished by high productivity.

Bunyip, which was produced by Farrer, is characterized by speed of maturation and resistance to stem smut. The type Nabawa is resistant to stem smut, relatively resistant to stem rust (yet in this respect is inferior to the Ford type) and is also distinguished by drought resistance. Its negative property is its low bread-baking qualities.

We note the type Geeralying, obtained by crossing the hybrid Huguenot with Bunyip, which is smut resistant and also partly resistant to stem rust. The latter quality comes from the Huguenot type, which in turn obtained it from hard wheat. The basic defect of Geeralying is the ease with which its kernels become scattered.

Of the new types we shall note Bena, obtained from the cross Hard Federation x Marshall 3, which is productive but susceptible to stem rust and stem smut.

From the cross Glyuas x Nabawa, the selector Limbour obtained the type Bencubbin, which is very productive and resistant to stem rust. In addition, this type is distinguished by good bread-baking qualities. By further selection the type Notadgin was evolved from Bencubbin.

We also note that in Australia fast-maturing Pusa 4 is being grown with success to the present day. It is one of the best selected sorts of India, with a high-quality grain, but with the basic defect of comparatively low yield.

Of the most recent selection types, we may point to the type Waratah, obtained from crossing Purplestraw with Gluyas Early.

414 Gluyas Early, which was developed by Gluyas from the South African varieties, is distinguished by considerable productivity under dry conditions and is grown today, chiefly in Western Australia. Gluyas Early, because of high productivity under climatic conditions was widely used for crossing in evolving the types Nabawa, Waratah, Glunclub, Aussie, Merredin, Clarendon, Noongaar, Bencubbin.

The Aussie type was obtained by crossing Federation x Gluyas Early. The Waratah type was obtained from the cross Purplestraw x Gluyas Early and Glunclub by the selector Prje from crossing Gluyas x Club (Triticum compactum).

Bycrossing Club x Yandilla King the type Free Gallipoli was obtained by the selectors Richardson and Gürdon. This type is particularly widespread in the state of Victoria. The defects of the type are susceptibility to stem smut and stem rust, and low bread-baking properties.

In the state of Victoria we find the type Ranee obtained by the selector Tullch, by crossing Indian x Federation. This is a productive type which unfortunately is effected by stem smut and possesses fairly low bread-baking qualities.

From the cross of the types Ford x Sultan, the selector Scott obtained the early Sword type, resistant to stem rust, and succeeding particularly well in Southern Australia. By means of crossing Gullen (Yandilla King x Indian Zaff) the selector Pridham evolved the Baringa type, distinguished by high productivity, resistance to stem smut and resistance to drought; as may be seen from the genealogy of this type, the Indian type Purplestraw participated in its formation. In respect

of flour-milling and bread-baking qualities, Baringa is distinguished by good absorptive capacity for water and has a strong but insufficiently elastic dough, but still is better in this respect than Jandilla King, Federation, Free Gallipoli, Nabava, and Bobbin. The grain of Baringa is hyaline; the qualities of the protein however, leave something to be desired. This type, in the opinion of Australian selectors has a great future.

From the cross of India 4 x Federation x Currawa x Gallipoli, the eminent Australian selector Godron created the type Ghurka. From the participants in the cross, the type Currawa was first obtained, and this in turn from Triticum durum and Triticum compactum, and apparently this participant transmitted to Ghurka resistance to drought and stem smut. The defect of Ghurka is low bread-baking qualities.

- 415 The selector Pridham in 1925 developed the type Bedin by the cross of South African types resistant to stem smut — Steinwedel with Thew. This type succeeds particularly well in New South Wales, although the grain quality is not high.

The type Dundee, evolved by the selector Pridham from the cross of Hard Federation x Sands x Cleveland, is resistant to stem smut and distinguished by strong, short straw, the fact that it does not strew, high productivity and satisfactory bread-baking qualities. Its defect is susceptibility to stem rust.

Finally, from the cross of Marshall 3 x Jonathan — Sunset-Zaff (hybrid of Fowler) the same selector evolved the type Gular, which combines high productivity and high flour qualities. As far as bread-baking qualities are concerned this type is not inferior to the Indian 4 type and is more productive than the latter.

We have here pointed out only the most interesting types, omitting many of secondary importance. The entire Australian selection is characterized by an exceptional intensity of hybridization work, great care being taken of the quality of the grain and speed of maturation, and resistance to bunt and loose smut, and leaf and stem rust.

On the whole, the hybrid sorts raised in Australia afford exceptional interest as they combine in themselves the most important qualities acquired by means of persistent and repeated hybridization and selection from the most varied agricultural groups.

All Australian types are as a rule spring types under our conditions, being distinguished by strong straw, usually of low or medium height, the fact that their grain is non-shattering, their low degree of bushiness, uniform stem structure, resistance to fungal diseases, and drought resistance under the conditions of the steppes and forest-steppes. The wheats of Australia as a whole are easy to thrash but are non-shattering. On the whole, they constitute a definite Australian ecotype, recognizable among the bulk of wheats because of their low degree of bushiness and their strong straw. The grain of Australian wheats is of a high quality and well filled out. Some of the Australian types of wheat are obviously worthy even of direct introduction into cultivation in the appropriate areas of our own country.

In connection with the demands of the world market, the main attention of Australian selectors, in contrast to the American, was devoted to white grain wheats.

The requirements of mechanization and the need to create fungus-resistant types, as well as the heightened requirements of the market for grain quality,

heightened the need for intense selection work which continues to this day. The history of the selection of spring wheats in Australia and the rapid replacement of one type by another in the search for combinations with the greatest possible number of valuable properties are exceptionally instructive, especially since it is comparatively well-documented and may be followed year by year.

We give below a list of the most common Australian wheat types and in indication of the states (Table 101) where they are grown. This list includes both the types which are widely known and those less well known, but all are characterized by valuable properties worthy of special attention for use as starting material in Soviet selection work.

All the Australian types are spring wheats and as a rule are characterized by a short first and second stage of development. In the overwhelming majority of 416 cases they practically do not react at all to vernalization in the sense of an accelerated growing period.



FIGURE 167. Soft wheat - Triticum
vulgare, Nabawa variety,
Australia.

The vast experience accumulated by Australian selection of wheat demonstrates quite patently the great significance of a correct choice of the initial material and demonstrates the particular value in this respect of South African and Indian types, which are characterized by speed of maturation and drought resistance and a strong stalk. The Australian data also throw into relief the value of the old, highly productive Western European type. The enormous hybridization work carried out in Australia, which is unique, has led to brilliant results and has to a considerable extent been responsible for the conversion of Australia into one of the world's most important wheat granaries.

The area under barley totals approximately 1.9 million hectares. The barleys of Australia are distinguished by speed of maturation. Four-rowed types are particularly common. Oats occupy about 651,000 hectares, consisting mainly of various imported Mediterranean forms (A. byzantina), resistant to crown rust and smut. The areas growing cereals in Australia are shown in Tables 101 and 102.

Table 101

Varieties of Australian wheat with an indication of the areas they occupy (acres)(according to data of 1935): Taken from H. Wenholz, "Improvement of Australian Wheat" Sydney; Department of Agriculture, New South Wales

Name of variety	New South Wales	Victoria	South Australia	West Australia	Queensland	All Australia	Area of type in percent of total wheat area
Nabawa	997,317	56,029	688,652	228,662	3,959	1949,619	14.6
Ghurka	62,043	837,762	122,484	3,199	—	1,026,488	8.1
Ford	761,018	1,463	175,439	58,845	11,326	1,008,091	8.0
Bencubbin	26,870	6,712	21,199	899,661	—	893,442	7.0
Free Gallipoli	109,383	598,425	141,999	2,322	—	852,129	6.8
Raneo	171,332	530,637	—	10,555	—	712,524	5.6
Waratah	329,461	18,140	221,607	97,730	549	667,487	5.3
Gluyas Early	—	6,785	191,559	250,958	20,149	469,451	3.7
Aussie	21,787	267	103,840	285,010	—	410,904	3.2
Sword	1,259	2,447	360,686	15,745	—	380,137	3.0
Glueclub	—	1,895	6,099	302,300	—	310,294	2.4
Dundee	278,078	6,482	8,548	721	—	293,823	2.3
Bobin	217,793	11,000	5,211	—	—	234,004	1.9
Jandilla King	150,612	1,796	876	12,169	—	165,453	1.3
Florence	28,708	—	68,930	574	47,377	145,589	1.1
Baringa	139,619	1,599	3,175	—	—	144,393	1.1
Bena	59,000	5,975	11,639	57,729	—	134,343	1.1
Federation	25,314	23,405	31,824	8,758	—	89,301	0.7
Currawa	22,930	12,483	41,111	—	7,845	89,289	0.7
Pusa 4	47,929	1,548	2,394	7,638	25,552	85,061	0.7
Marshall's 3	72,191	—	1,033	—	—	78,110	0.7
Canberra	19,813	410	17,866	24,124	632	62,845	0.7
Major	—	28,476	5,372	2,168	—	36,016	0.3

The chief areas for cereal growing in Australia vary considerably in climatic conditions, soils, incidence of diseases, sowing dates, and crop flora. They may be divided at least into three agroecological areas in the narrow sense of the term.

- 89. Southern coastal region of Australia, including Tasmania.
- 90. Southeastern Steppe region of Australia.
- 91. Dry Regions of Southwestern Australia
- 92. New Zealand agroecological region.

Table 102

Areas sown with cereal crops in Australia

States	Wheat	Oats	Barley
	(1,000 hectares)		
New South Wales	1570	90	3.9
Victoria	97	211	3.7
Queensland	118	1.9	3.8
Southern Australia	1246	133	132
Western Australia	1058	170	11.1
Tasmania and other islands	4.4	127	2.4

89. Southern Coastal Region of Australia, Including Tasmania

The southern coastal strip of Australia where such important centers as Sydney and Melbourne are located, is characterized by considerable humidity. The amount of rainfall varies from 600 to 1200 mm, as a result of which cereals are usually strongly affected by rust and other fungal diseases. The southern coastal agricultural strip is adjacent on the south to the Australian Alps. This region includes the Southeast of the state of Victoria and from the point of view of climate also includes the southwestern corner of Australia. A large part of Tasmania may also be associated with these from the climatic point of view.

Wheat is but little cultivated here as a grain crop, and is used mainly for fodder purposes: green forage and hay. Accordingly, the wheat flora is not the same as in other wheat areas. Thus, together with beardless hybrids of hard and soft wheats such as Huguenot, developed by Fowler, new types are grown here for the same purpose: Thew, Warren and Clarendon. As a whole, the southern and coastal areas are more suitable for oat cultivation than for wheat. In Tasmania, as a result of the low temperature, wheat is being displaced by oats. We present the climatic data for these areas in Table 103.

Rainfall occurs predominantly in winter and therefore, during the critical developmental period and maturation, the destructive action of drought is often felt. The harmful influence of yellow and brown rust makes comparatively little impression. Such leguminous seed crops as peas and lentils grow poorly here, and the same is true of flax, potatoes and the sugar beet. The principal negative factor is the drought at maturation. It is for this reason that corn and French beans are not grown here. Even with irrigation cereals suffer from atmospheric drought

418 during the period of the maturation of seeds. Cotton is raised only on irrigated areas.

Soils consist of krasnozems (red soils) and serozems (gray soils), which are nearly neutral in reaction and poor in organic substances. The natural vegetation is mainly prickly bushes (sagebrush).

90. Southeastern Steppe Region of Australia

The southeastern steppe areas of Australia comprise the southeastern part of Queensland, a wide strip of New South Wales, a large part of the state of Victoria, and eastern parts of the state of Southern Australia. These areas are mainly characterized by chernozem soils, dry climate and high November, December and January temperatures. In the hinterland, rain falls comparatively uniformly over the year, but usually in insufficient quantities, its annual amount averaging 500 - 600 mm. Grains here, particularly in the South are usually subjected to rust infection as well as the harmful action of low temperatures. In the more southern areas, stem and yellow rust are fairly widespread. It is here that the principal wheat lands are concentrated. The average yield is some 7 - 8 centners per hectare. Considerable amounts of oats and barley are grown. The natural vegetation is that typical of the steppe.

Table 104 presents certain climatic data for these areas.

91. Dry Regions of Southwestern Australia

Whereas the coastal strip of southwestern Australia is similar to the coastal strip of the Southeast, which is marked by excess humidity, the interior areas of Southwest Australia, where considerable wheat lands are concentrated, are characterized by a dry climate. Here the soils, in contrast to the areas in Southeastern Australia, are predominantly chestnut and brown. Rainfall fluctuates between 260-350 mm. A negative climatic factor is the drought during maturation, responsible for the shortened growth period. Yields of the cereals are lower than in the preceding region, averaging 6-7 centners per hectare.

We present the typical climatic data for the region in Table 105.

92. New Zealand Agroecological Region

The islands of New Zealand are situated at a distance of some 1900 kilometers from Australia. In climatic and soil agricultural conditions and in the composition of the wild flora, New Zealand differs sharply from Australia, constituting an independent botanical region. The flora of New Zealand is rich in endemes: tree ferns (Cyathea delbata, C. medullaris, Dicksonia fibrosa, D. squarrosa, etc), unique species of native birches (Nothofagus cliffortioides, N. truncata, etc), and special bushy species of Veronica (Veronica). It is from New Zealand that spinning Dra-caenea and New Zealand flax (Phormium tenax) originated. The total agricultural area at the present time is estimated at about 900,000 hectares (1940).

Table 103
Climatic data of the areas of the Southern Coast of Australia, including Tasmania

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Albany 35°02' South lat. Elev. 12 m	Precipitation (mm).....	16	23	34	65	116	134	122	128	93	71	33	25	860
	Av. temp. (°C).....	18.9	19.1	18.2	16.8	14.6	12.7	12.0	12.9	13.3	14.3	16.3	17.9	15.5
	Av. abs. ann. min. temp. (°C) ...	—	—	—	—	—	—	—	—	—	—	—	—	—3.0
Perth, Southwestern Australia 31°57' South lat. Elev. 12 m	Precipitation (mm).....	9	12	19	41	122	176	164	142	88	54	20	15	862
	Av. temp. (°C).....	23.2	23.3	21.7	19.3	15.9	13.7	12.8	13.3	14.5	16.0	19.0	21.7	17.9
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—1.0
Launceston, Tasmania 41°27' South lat. Elev. 9 m	Precipitation (mm).....	46	32	40	51	67	84	75	69	75	68	45	48	700
Missoral, Tasmania 42°13' South lat. Elev. 23 m	Precipitation (mm).....	76	58	79	113	120	146	146	137	117	110	84	79	1265
Hobart, Tasmania 42°53' South lat. Elev. 43 m	Precipitation (mm).....	45	40	42	48	46	57	53	45	53	56	62	48	595
	Av. temp. (°C).....	16.7	16.8	15.2	12.9	10.3	8.3	7.6	8.9	10.6	12.2	13.9	15.7	12.1
Sydney 33°51' South lat. Elev. 44 m	Precipitation (mm).....	90	114	122	140	127	121	118	73	71	70	71	70	1187
	Av. temp. (°C).....	22.0	21.8	20.7	18.2	14.8	12.6	11.5	12.8	15.1	17.6	19.4	21.1	17.3
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—4.0
Melbourne 37°50' South lat. Elev. 35 m	Precipitation (mm).....	47	47	54	55	53	52	46	45	61	65	56	55	696
	Av. temp. (°C).....	19.7	19.8	18.1	16.2	12.3	10.2	9.3	10.6	12.3	14.3	16.3	18.3	14.7
	Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	—1.0

New Zealand is a country rich in natural and artificial pastures. The quantity of cattle in this small country is enormous—4,254,600 head of horned cattle and 30,114,000 sheep (1936). The field crop flora resembles that of Denmark to a considerable extent because of the predominating amount of forage grasses and tubers. For 1935-1936, the flora of New Zealand field crops was distributed as follows:

<u>CROPS</u>	<u>AREA SOWN (Thousands of hectares)</u>
Wheat	105
Oats	151
Barley	12
Corn	7
Peas	16
Beans	53
Turnips	142
Potatoes	94
Mangelwurzel (Mangrove)	5
Cereals for green forage	86
Clover mixed with forage cereals	280
Lucerne	17

As a result of the great distance from population centers, New Zealand has developed the cultivation of wheat to a considerable degree to ensure the needs of her population of 1½ million.

The agricultural areas of New Zealand are concentrated mainly in the east of South Island and in the foothill and low-lying coastal strip and in the extreme south of North Island.

The soil and climatic conditions of the agricultural areas of New Zealand are extremely favorable for the attainment of high yields, and in this respect New Zealand occupies one of the leading positions in the world. The soils are brown and yellow earth. The yield of wheat on the average attains 18-20 centners per hectare, of oats 25-27 centner per hectare, of barley 22 centners per hectare, of peas 12 centners. Under favorable conditions wheat yields rise to 40 and oats to 50 centners per hectare.

The average amount of rainfall in the basic agricultural areas varies from 600-1000 mm, with a comparatively favorable distribution (Table 106).

The flora of wheat types is fairly uniform and limited chiefly to the two most common types: soft spring wheat—the solid Straw Tuscan—and spring wheat of the Hunters type. Of the other spring types, Garnet and Marquis from Canada are cultivated in small quantities, as well as Federation from Australia and Ionian II winter wheat from England. The Mayer type succeeds here only in the most northerly areas of the South Island. In the latter part of spring, the Canadian spring type Garnet is sown. In recent years, Yumbuck types have begun to be common, distinguished as they are by their rapidly maturing qualities, as well as Dreadnought and the hybrid Cross 7 evolved by the New Zealand Wheat Institute. Tuscan is a universal type growing under varied conditions. It has a comparatively high speed of maturation, in contrast to Hunters, and its grain is non-shattering. This type has been introduced from Mediterranean countries. At the present time it takes up some 70% of the entire wheat area. The Hunter type raised in England is a recent importation, characterized by a sprawling bush and a compact ear and grows on rich dense soils. There have also been attempts in New Zealand at growing English wheat, Triticum turgidum (rivet).

Table 104
Climatic data of the southeastern steppe areas of Australia

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Goulburn (New South Wales) 34°45' S.lat. Elev. 639 m	Precipitation (mm).....	64	61	53	43	48	52	45	44	52	51	54	55	622
Cootamundra (New South Wales) 34°39' South lat. Elev. 330 m	Precipitation (mm).....	46	34	43	48	48	70	55	54	50	51	41	44	584
Albury (New South Wales) 36°06' S.lat.	Precipitation(mm).....	39	48	49	50	64	87	71	71	65	74	48	42	708
Bendigo (Victoria) 36°46' S.lat. Elev. 251 m	Precipitation (mm).....	32	33	37	37	52	64	50	54	55	48	36	29	531
Horshum (Victoria) 36°43' S.lat. Elev. 138 m	{ Precipitation (mm).....	17	25	25	32	49	56	42	46	49	41	39	27	442
	{ Av. temp. (°C).....	21.1	21.8	18.6	14.9	11.6	9.2	7.4	9.6	11.6	13.8	17.6	20.1	14.8
Mudgee (New South Wales) 32°35' S.lat. Elev. 468 m	Precipitation (mm).....	53	57	48	45	47	65	48	47	54	50	51	50	618

Table 105

Climatic data of the South-western dry areas of Australia

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Yalgu, Australia 28°23' South lat. Elev. 318 m	Precipitation (mm).....	16	32	27	14	32	47	34	27	13	9	6	10	267
	Av. temp. (°C).....	28.7	28.1	25.7	21.7	16.3	13.2	12.1	13.2	16.7	19.1	23.9	27.1	20.4
	Av. abs. ann. min. temp. (°C).....	--	--	--	--	--	--	--	--	--	--	--	--	0.0
Kalingiri 31°39' South lat. Elev. 246 m	Precipitation (mm).....	9	12	24	19	42	55	53	41	80	20	10	15	330
Katanning 33°42' South lat. Elev. 337 m	Precipitation (mm).....	10	15	24	30	56	73	75	62	50	40	16	15	466
	Av. temp. (°C).....	21.6	21.2	19.1	16.0	12.9	10.8	9.8	10.3	12.0	13.9	17.7	20.3	15.5

Table 106
Climatic data of the New Zealand Agroecological Region

Place	Data	Month												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Christ Church 43°32' South lat. Elev. 8 m	{ Precipitation (mm).....	66	49	52	51	66	71	69	47	46	44	52	56	659
	{ Av. temp. (°C).....	16.2	15.7	14.1	11.7	8.6	6.4	5.9	6.8	9.6	11.6	13.3	15.3	11.3
Nelson 41°16' South lat. Elev. 4 m	{ Precipitation (mm).....	71	77	79	79	80	96	92	78	100	91	80	74	997
	{ Av. temp. (°C).....	17.6	17.3	15.6	13.3	10.5	8.4	7.8	8.3	10.6	12.4	14.2	16.1	12.7
Dunnydin 45°52' South lat. Elev. 73 m	{ Precipitation (mm).....	84	77	78	74	82	83	79	80	73	81	86	90	966
	{ Av. temp. (°C).....	14.8	14.5	13.3	11.3	8.8	7.1	6.3	7.2	9.3	10.9	12.2	13.8	10.8
Ophir (av. for 7 years) 45°05' South lat. Elev. 300 m	{ Precipitation (mm).....	50	30	38	38	22	21	19	20	28	36	40	36	378
	{ Av. temp. (°C).....	17.3	17.0	14.4	11.3	5.7	2.8	3.1	5.3	8.6	11.3	11.7	15.6	10.4
Wellington 41°18' South lat. Elev. 3 m	{ Precipitation (mm).....	67	69	70	82	101	103	114	94	82	84	77	68	1011
	{ Av. temp. (°C).....	16.7	16.6	15.5	13.7	11.4	9.7	8.8	9.2	10.9	12.3	13.6	15.6	12.8

South Africa

Of the territory of 122,000,000 hectares comprising the Union of South Africa, agriculture at present occupies 4,000,000 or roughly 3% of the total area. The part played by grain crops in this is about 2,500,000 hectares. The chief field crop is corn, which in 1934 occupied 570,000 hectares: there were 186,000 hectares of oats, about 60,000 under barley, and 80,000 under sorghum.

The wild flora of the Capeland is exceptionally rich. It produces more than 6,000 species, a considerable part of which is endemic. Cape Province constitutes a special vegetative region. In correspondence with the variety of wild vegetation, the agricultural conditions in the Union of South Africa are highly variable.

In contrast to Australia, nearly one-half of the entire arable area of the Union of South Africa lies at an elevation of over 1,000 meters above sea level. Accordingly the climate of the farming areas of the Union is comparatively cool. Because of the considerable elevation above sea-level, the negative action of low temperatures makes itself manifest. The amount of rainfall definitely increases as we go from west to east—from Cape Province to the eastern coast and Natal and the Transvaal.

In Cape Province a large part of the territory is characterized by an amount of rainfall of 125-400 mm. In the Southwest of the province, 500-2500 mm. In Orange Free State, the greater part of the territory receives from 400-650 mm of rainfall. In the Transvaal, three-fourths of the territory are characterized by an annual rainfall of 380-625 mm. In Natal the average annual rain for a large part of the territory is 625-1,000 mm.

- 423 A considerable part of the fields sown with cereals in the Union of South Africa is raised without irrigation. Irrigated cultivation of wheat is common in Cape Province, Orange Free State and the Transvaal. The cultivated lands of these areas adjacent to the Kalahari Desert are particularly subject to the action of dry winds. The lethal effect of rust is very rarely manifested here.

Definite laws seem to govern the distribution of rainfall in South Africa. Cape Province is characterized by rainfall occurring mainly during winter — from April to October. In contrast to this, the regions lying to the south receive their rainfall in summer — from October to March. The highest yields of wheat and oats are obtained in the southwestern part of Cape Province. Wheat takes up nearly two-fifths of the sown South African area, but in quantity of grain Cape Province produces more than half of the wheat of the whole country.

The cultivation of wheat is distributed among three chief South African areas:

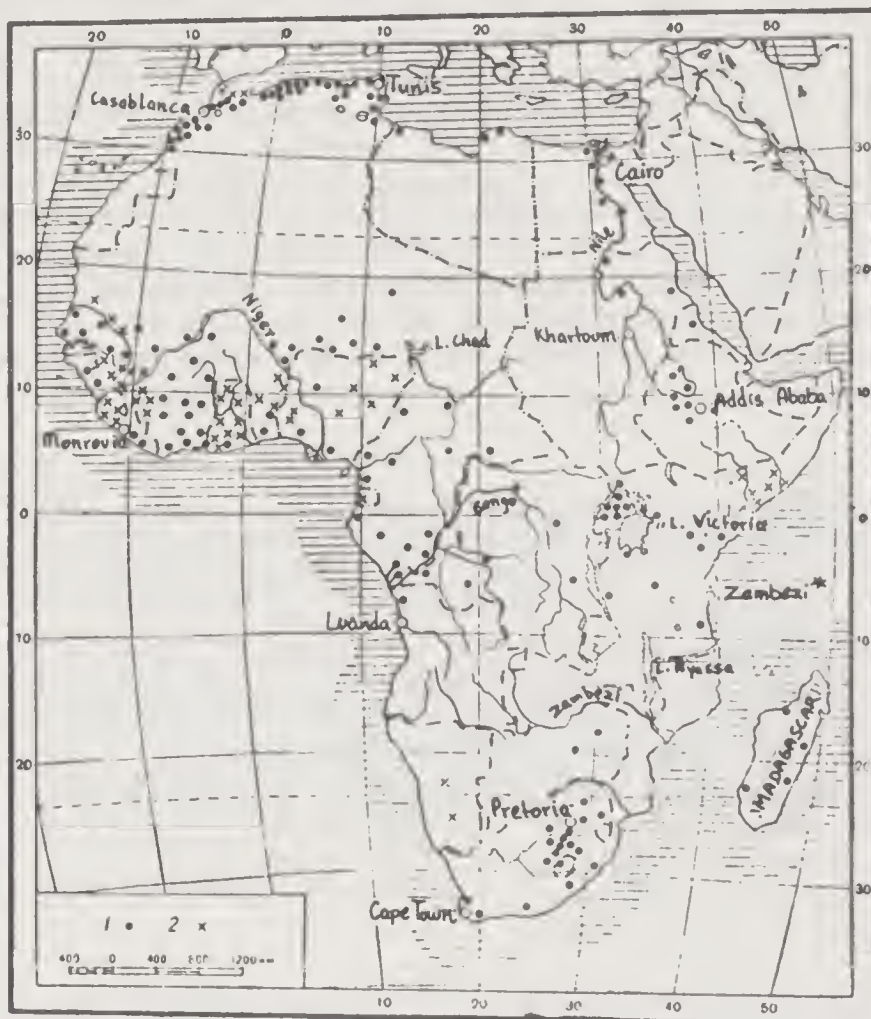
1. Southwestern part of Cape Province, where half of the country's wheat fields are concentrated.
2. High eastern plateaus of the Orange Free State.
3. Southern areas of the Transvaal around Pretoria.

In Cape Province the wheat fields are found to be concentrated in:

1. Massif of Malmesbury to the north of Capetown.
2. Caledon Massif southeast of Capetown.
3. Large massif of South Karoo to the north of Caledon. .

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

The wheat-growing stretches occur chiefly in a steppe landscape. The most valuable wheat area is considered to be the southwestern part of Cape Province, characterized by winter rainfall. As a result of the destructive effect of rust and drought, which recurs periodically, the yields of the wheat fields of the Union of South Africa are among the lowest in the world. On an average, the wheat yield over the last ten years has not exceeded 6 centners per hectare; the yield of oats amounted to 5 centners per hectare. In contrast to Australia, which has exceptionally bright prospects for the development of wheat in the future, the Union of South Africa, according to the conclusions of a special commission of the Ministry of Agriculture of the Union of South Africa established in 1919, does not have very good prospects in this field. The wheat areas best suited for exploitation, according to the conclusions of the Commission, have almost attained the practical limits under existing economic conditions in the country. An extension of the area under wheat is possible only by increasing the irrigation system and radically improving the existing types.



Map 9. Africa. Agricultural areas as of 1936.

(Cultivated non-fallow area including gardens and vineyards). Each dot represents 250,000 hectares and each x represents 10,000 hectares.

Compiled by I. F. Makarov and I. V. Chekan.

Edited by Acad. N. I. Vavilov.

Wheat and barley cultivation in the Union of South Africa had its origin in 1652. The first types were shipped from Holland. Large quantities of types later began arriving from India, Italy, Egypt and France. As a result of the blighting effect of drought and in certain years also of rust, and to a considerable degree of the haphazard selection, the types of the South African flora underwent considerable

* [Apparently "Zanzibar" is intended. Translator's note]

changes during two centuries*. The history of these changes has been studied in a comparatively satisfactory manner. In the course of the last two centuries, the Union of South Africa tried out a large number of European types, while in recent years intensive use has been made of new hybrid types evolved in Australia.

Problems of the fight against rust began to attract the attention of South African farmers a long time ago. The first Imperial Conference on Combatting Rust, which took place in Australia in March 1892, attracted the attention of agronomic circles in the Union of South Africa. By then it had already become absolutely clear that the principal method to combat rust consisted of the introduction of resistant types into cultivation. A considerable role in this respect was played by hard wheats, such as Medea, Golden Bowl and later by our types, Chernouska and Beloturka. The Italian soft wheat Rietti proved to be resistant, as well as types, such as Zwartaar and Zwartbard, which evolved from older populations by selection. The types of hard wheat Chernouska and Medea proved that they could produce high yields under South African conditions. By the end of the 19th century, of the varied range of types which has been tested by practical workers, fast maturing types were selected, such as Steinwedel and Gluyas. Of the drought resistant types, Klein x Kering, a small grain soft wheat was noteworthy. According to its habitus, this was a typical Indian type. The most common types in recent decades in South Africa have been the following: hard wheats—Chernouska and Beloturka; soft wheats—Rietti, Zwartaar, Zwartbaard, Gluyas Early, New Resistance, Federation, Red Wolkeren, White Wolkeren and Pearl Spring. In recent years regular use has been made of the products of Australian selection. New hybrid types of Australian wheat have been widely introduced into the Union. Thus Australia, which in its time made considerable application of the old South African types Gluyas and Steinwedel for purposes of hybridization, in turn began to supply the Union with new hybrid types.

All South African wheats, like the Australian, when placed under our steppe and forest steppe conditions, are typical spring strains. Oats, which are an important crop in the Union of South Africa, are represented mainly by types belonging to the species A. byzantina. The South African oat taxonomists, De Villiers and Sim**, combine Mediterranean types of oats into a group called Algerian. This includes types known in South Africa as Algerian, Smyrna, Texas Red, Rastpruf, Bancroft, Fulgum and Birt, which are typical representatives of Mediterranean oats, borrowed from the USA or directly from Mediterranean countries. The types Sunrise and Ruakura, botanically belonging to Avena sativa, are apparently native hybrids of Mediterranean oats with European. Hybridization of the former took place with the latter in Australia, whence it was imported into South Africa. The type Ryakura was also obtained from Australia. In the Transvaal the following types are grown: White Dun, Hejira, and Bassen.

426

The barley of the Union of South Africa is represented principally by four-rowed forms; less often six-rowed forms are encountered. Two-row beer-brewing barley is encountered more rarely. Until recently no serious work of selection was carried out with barleys***.

* J.H. Neethling, Wheat Varieties in South Africa: Their History and Development Until 1912, Sc. Bull., 108, Union of South Africa, Department of Agriculture, Pretoria, 1932.

** De Villiers, P.J.R., and Sim, J.T.R., Classification of Oat Varieties grown in Western Cape Province, Union of South Africa, Department of Agriculture, Pretoria, 1930.

*** Sim, J.T.R., Classification and Description of Barley Varieties Grown in Africa, Union of South Africa, Department of Agriculture, Pretoria, 1930.

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

The method of comparative testing of types was used to select the most productive foreign types multiplying in South Africa. Of these, the most common is the old six-rowed type Cape, from which Early Cape was evolved by means of selection. Both of these types are most common in the Union of South Africa. The type Trebi, which is standard in the United States and introduced from Turkey, has begun to be put under cultivation with success. In contrast to preceding types, this is a comparatively late maturing type. Beardless barleys of the furcate type are also being raised. These forms were evidently borrowed from Asia and belong to the variety of naked-grain hooded barleys, which, thanks to the absence of beards, are grazed on willingly for green forage.

The agricultural areas of South Africa may be divided into three agroecological regions:

93. Coastal Area of South Africa.
94. Southwestern part of Cape Province.
95. Interior steppe agroecological region of South Africa.

93. Coastal South African Agroecological Region

The coastal South African region is characterized by an amount of rainfall of over 1000 mm per year. Tropical, subtropical, and other crops are the chief types grown. This zone has not been considered by us in detail since it bears no direct relation to the crops we are considering. Here only small quantities of beans and cereals are cultivated, the cereals in particular being used for green forage. Corn grows well.

94. Southwestern Part of Cape Province

This agroecological region is characterized by winter rains, and its climate resembles that of the Mediterranean region, with regard both to the comparatively adequate humidity and the distribution of rainfall.

In addition to wheat, oats, and barleys, grapes and various food crops of those types which are peculiar to a moderately subtropical zone are grown. The main area under cereals lies in the south-western part of Cape Province. The range of the types is indicated above. The yields here are stable and higher than in the interior part of the Union of South Africa. The climatic data are presented in Table 107.

Table 107

Climatic data of the southwestern part of Cape Town province

Place	Precipitation			Average temperature		
	Jan.	May	Annual	Annual	Warmest month	Coldest month
Cape Town	111	72	650	16.4	20.4	12.7
Simonstown	—	—	740	17.6	21.5	13.8
Table Mountain	—	—	1310	12.2	15.6	8.6
Malmesbury	—	—	170	—	—	—
Bredasdorp	—	—	500	—	—	—
Mossel Bay	—	—	440	17.0	20.6	13.7

95. South African Steppe Agroecological Region

This agroecological region includes Central Transvaal and the eastern elevated plateaus of the Orange Free State. It is distinguished by less rain than the preceding one, and the fact that the rain occurs mostly in summer, from October to 427 March. Table 108 presents the climatic data characteristic of this agroecological region as registered at Johannesburg.

The climatic data of another point of the region, Pretoria, Transvaal, 25°45' south latitude, elevation 1430 meters above sea level, are the following: Temperature (°C), average for 7 years: Temperature of warmest month, 21.4; coldest 11.40; average temperature minima -3.1; number of days with temperature above 5°C is 365; annual amount of rainfall (average for 18 years), 660 mm.

In elevated areas, the harmful influence of low temperatures is felt. The sowing of cereals occurs in July-August (winter sowing). The type of flora of the cereals, in contrast to the preceding region, is characterized by a great resistance to drought and rapidity of maturation.

Table 108

Climatic data for Johannesburg (Transvaal, 26°11' S.lat. Elev. 1220 m)

Data	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Precipitation (mm).....	159	124	104	55	18	5	5	6	24	32	101	120	776
Av. temp. (°C).....	18.3	17.7	17.1	14.6	11.3	8.6	8.6	10.9	14.6	17.5	17.8	17.8	14.6
Av. abs. ann. min. temp. (°C) ...	—	—	—	—	—	—	—	—	—	—	—	—	-2.1
Abs. min. temp. (°C).....	—	—	—	—	—	—	—	—	—	—	—	—	-6.1
Days over +5° C.....	—	—	—	—	—	—	—	—	—	—	—	—	365

INDEX OF PERSONAL NAMES

NOTE. The page numbers indicated in this index are those of the Russian original and can be found in the left hand margin of the printed translation. Due to technical reasons, however, figures, photographs, and tables have, in some cases, been printed on one of the adjoining pages.

- | | |
|--|-------------------------------|
| AKERMAN, A., 38 | Ducellier, L., 235 |
| Allard, G., 35 | ELLADI, E. V., 9 |
| Antropova, V. F., 9 | FARRER, U., 410, 413, 417 |
| Azzi, G., 75, 88, 94, 97, 115, 266 | Federov, An. A., 18, 116, 136 |
| BACKHOUSE, N., 388 | Firsova, M. K., 36, 45 |
| Baĭkov, A. I., 18 | Flitner, N., 50 |
| Bakhteev, F. Kh., 8, 35 | Fortunatova, O. K., 9 |
| Baranov, P. A., 172 | GARNER, U., 35 |
| Barulina-Vavilova, E. I., 9 | Geiger, 88 |
| Bensen, B. M., 25 | Gerbikh, A. A., 9 |
| Berg, L. S., 9 | Glyas, 413 |
| Berger, A., 388 | Gökgöl, M., 85, 97, 109 |
| Bolley, G., 336 | Gordon, G., 414 |
| Brokema, Ch., 289 | Goulden C. H., 361 |
| Bukasov, S. M., 6, 23 | Grats, 88 |
| Bukinich, D. D., 23, 151 | Gregor, G. N., 25 |
| CAPELLI, 405 | Gresley, 413 |
| Chekan, I. V., 182, 189, 236, 356, 387, 409, 424 | Gromachevskiĭ, V. N., 115 |
| Chermak, E., 401, 405 | Grossheim, A. A., 121 |
| Chesnokov, P. G., 49 | Guerden, 414 |
| Columella, 61 | HARPER, Y., 35 |
| DARWIN, C., 68, 87 | Hein, 373 |
| Dekaprelevich, L. L., 8, 9, 115, 127, 260 | Hemsley, 16 |

- Howard, A., 45, 191
- Howard, G., 45, 191
- Hurst, R., 410
- Huxley, J., 7
- KAMINSKIĬ, A.A., 88
- Khadzhinov, M.I., 123
- Kikhara, H., 127
- Klein, E., 388, 405
- Kobelev, V.K., 97
- Koente, M.G., 9
- Koeppen, 88
- Kostetskiĭ, 314
- Kostyuchenko, I.A., 76
- Kozhukhov, I.V., 123
- Krasovskaya, I.V., 41, 42
- LATHOUWER, V., 41
- Lebedev, D.V., 9
- Lyapunova, K., 50
- Limbour, E., 413
- Lobanova, M.P., 9
- Lur'e, I.M., 50
- Lysenko, T.D., 35
- MAKAROV, I.F., 9, 82, 182, 189, 236, 356, 387, 409, 424
- Maksimov, N.A., 38, 41
- Makushina, E.N., 8
- Marshall, R., 410
- Mat'e, M., 50
- Menabde, V.L., 8, 115, 127
- Mordvinkina, A.I., 9
- NEETHLING, J.H., 425
- Nevskiĭ, S.A., 16
- Nikolaev, V.F., 18
- ORLOV, A.A., 117, 180
- PAL'MOVA, E.F., 97
- Papadakis, G.E., 41, 45, 94, 115, 239, 268, 270, 282
- Percival, G., 76, 190
- Piotrovskiĭ, B., 50
- Pisarev, V.E., 253, 340
- Platchek, E.M., 313
- Prasolov, L.I., 88
- Pridham, G., 410, 414, 415
- RAĬKOVA, I.A., 172
- Razumov, V.I., 35
- Richardson, A., 414
- Rozanova, M.A., 9
- Rubinshteĭn, E.S., 88
- Rue, 410
- SAUNDERS, C., 366
- Scott, 413, 414
- Selyaninov, G.T., 88
- Semenova-Tyan-Shanskaya, N.Z., 9
- Shabliovskaya, A.N., 9
- Shepeleva, A.M., 9

- Shtrube, I., 405
- Sim, J., 425, 426
- Sinskaya, E.N., 8, 23, 36, 71, 79, 337
- Skvortsov, B.V., 257
- Smirnova, M.I., 35
- Strampelli, N., 268, 401, 405
- Sutton, G., 413
- THEOPHRASTUS, 61
- Todaro, F., 268
- Trabut, L., 45
- Tullch, 414
- Tumanyan, M.G., 115
- Tumanov, I.I., 38, 41, 176
- Tupikova-Freiman, A. Iu., 37
- Turesson, G., 25, 79
- UDOL'SKAYA, N.L., 41, 332
- Uzepchuk, S.V., 6
- VARRON, 61
- Vavilov, N.I., 5 - 10, 16, 18, 21, 23,
25, 33, 50, 68, 73, 76, 82, 117, 124,
151, 178, 182, 189, 236, 327, 356,
387, 388, 409, 410, 424
- Villiers, P. de, 425
- Vilmorin, 266, 284
- Virgil, 61
- Votchal, A.E., 42
- WALDRON, L., 366
- Wenholz, G., 410, 416
- Williamson, 399
- YAKUBTSINER, M.M., 8, 9
- ZARUBAĬLO, T.Ia., 76
- Zhegalov, S.I., 328
- Zherebina, Z.N., 42
- Zhukovskii, P.M., 6, 8, 23, 97, 109, 127

INDEX OF COMMON PLANT NAMES

NOTE. The page numbers indicated in this index are those of the Russian original and can be found in the left hand margin of the printed translation. Due to technical reasons, however, figures, photographs, and tables have, in some cases, been printed on one of the adjoining pages.

- ACACIA, 194
- Acacia, Lenkoran, 142
- Aegilops (wild oat), 94
- Apple tree, 156
- Apricot, 160, 175, 177
- Arachis, 82
- BANANA, 197, 223, 390
- Baobab, 200
- Barley, 7, 8, 11, 15, 19, 20, 23, 24, 35-37, 41, 45, 46, 49, 52, 53, 62, 76, 79, 82, 85, 86, 94, 98, 102, 106, 107, 109, 116, 119, 121, 125-129, 134, 136, 138, 141, 142, 144, 147, 148, 151, 153, 158, 162, 168, 171-173, 175-178, 180, 185, 187, 189-192, 195-197, 201-205, 212, 216, 229, 236, 240-243, 245, 246, 252, 253, 255, 258-260, 268, 274, 277, 312-314, 319, 321, 322, 327, 329, 336, 337, 339, 340, 344, 348, 350, 352, 354, 357, 359, 366, 367, 369, 373, 374, 382, 399-401, 406, 408, 416, 418, 420, 422, 425, 426
- Beans, 7, 20, 23, 45, 54, 61, 75, 82, 109, 132, 134, 142, 173, 175, 176, 190, 195, 207, 216, 221, 277, 282, 283, 287, 293, 382, 399, 406, 420, 426
- Beans, French, 72, 123, 239, 245, 264, 265, 268, 359, 374, 405, 417
- Beans, horse, 60, 177, 327
- Beardgrass, 147
- Brome grass, 42
- CABBAGE, 61, 196
- Cardamon, 187
- Chick pea, 7, 20, 23, 54, 61, 65, 75, 82, 86, 105, 109, 110, 116, 136, 139, 164, 185, 196, 207, 209, 262, 313, 382, 399, 400, 406
- Cinnamon, 187
- Citrus, 239, 411
- Clover, 281, 282, 319, 323, 329, 420
- Clover, Persian, 175
- Clover, Red, 300
- Cocoa, 400
- Cocoanut palm, 187
- Coffee, 83, 84, 187, 400
- Coletotrichum, 212
- Colza, 173, 175, 177, 185
- Corn, 51, 61, 69, 82, 83, 114, 123, 127, 144, 148, 239, 240, 243, 264, 265, 268, 283, 300, 302, 308, 367, 373, 374, 400, 405, 417, 420, 422, 426
- Cotton, 11, 57, 82, 148, 168, 185, 187, 224, 239, 240, 242, 265, 268, 283, 300, 374, 418

- DARNEL, 142
- Date palm, 235
- Dracaena, 419
- EMMER, 49
- Eucalyptus, 192, 390, 410
- FEATHERGRASS, 147, 344
- Fescue, 147
- Flax, 7, 9, 15, 19, 20, 23, 26-28, 36, 42, 49, 61, 66, 67, 71, 76, 82, 85, 86, 94, 98, 114, 121, 126, 134, 142, 157, 165-168, 173-175, 184, 185, 187, 189, 192, 195-197, 206, 207, 212, 225, 226, 229, 240, 245, 259, 260, 268, 277, 281, 283, 284, 287, 300, 308, 313, 319-321, 323, 327, 332, 337, 349, 353, 354, 357, 358, 366, 369, 382, 388, 399, 401, 418
- Flax, New Zealand, 419
- Fusarium, 356, 366
- GINGER, 187
- Gold of pleasure, 71
- Grass pea, 7, 20, 23, 61, 75, 86, 102, 165, 172, 173, 175-177, 192, 195, 196, 207, 216, 262
- HAYNALDIA, 94
- Hemp, 85, 319, 337, 339
- Hemp, weed, 339
- IRONWOOD, 14, 142
- JAPANESE PERSIMMON, 134
- Jute, 187
- LENTILS, 7, 20, 23, 35, 61, 63, 64, 75, 82, 85, 86, 102, 104, 109, 114-116, 134, 172, 175, 190, 192, 195, 196, 207, 208, 216, 221, 261, 313, 329, 406, 418
- Lentils, French, 175, 261
- Lucerne, 79, 175, 192, 240, 283, 300, 382, 399, 401, 420
- Lucerne, blue, 388
- Lupin, 35, 45, 327
- MAGNOLIA, 36
- Mangelwurzel, 420
- Mango tree, 187
- Meadow grass, 65, 353
- Melon, 51, 223
- Mildew, powdery, 47, 49, 76, 126, 127, 148, 153, 174, 253, 272, 273
- Millet, Italian, 127
- Millet, pearl, 187
- Mulberry, 175, 177
- Mustard, 37, 196
- OATS, 7, 9, 11, 20, 23, 25, 36, 39, 45, 57, 58, 68, 75, 76, 82, 85, 86, 116, 178, 180, 195, 212, 258, 260, 261, 273, 274, 277, 281, 284, 287, 289, 292, 299, 302, 306, 308, 313-315, 319, 321-323, 327, 332, 336, 337, 339, 340, 343, 348, 350, 352, 354, 355, 357, 366, 369, 373, 374, 382, 388, 394, 401, 408, 416, 417, 418, 420, 422, 425, 426
- Oats, Abyssinian, 206
- Oats, Byzantine, 16, 399
- Olive tree, 85, 218, 235

- Onions, 61, 212
- Opium poppy, 178
- PEAR, 124
- Peas, 7, 20, 23, 45, 54, 61, 62, 72, 75, 82, 85, 86, 98, 102, 103, 109, 116, 134, 148, 161, 165, 167, 172, 173, 175-177, 192, 195-197, 201, 206, 216, 219, 240, 245, 248, 277, 282-284, 287, 293, 314, 320, 327, 328, 340, 344, 353, 357, 359, 366, 400, 418, 420
- Peas, Abyssinian, 195
- Plum, 124
- Polyspora, 212
- Potato, 25, 36, 260, 277, 282, 283, 300, 310, 321, 323, 327, 329, 336, 350, 353, 359, 373, 388, 395, 396, 406, 418
- Pumpkin, 374, 405
- QUININE TREE (Cinchona), 397
- Quinoa (Chenopodium), 405
- RADISH, 36, 61, 250
- Rice, 70, 73, 74, 78, 143, 187, 240, 243
- Rust, 49, 76, 126, 148, 153, 168, 172, 182, 187, 273, 308, 399, 400, 413, 418, 425
- Rust, barley, 212
- Rust, brown, 19, 28, 46, 49, 65, 79, 127, 144, 168, 171, 190, 191, 198, 212, 229, 240, 241, 248, 253, 272, 275, 306, 308, 367, 418
- Rust, crown, 16, 49, 109, 212, 302, 306, 373, 374, 416
- Rust, leaf, 140, 182, 229, 388, 415
- Rust, stem, 46, 49, 239, 240, 260, 268, 272, 283, 350, 359, 361, 366, 369, 374, 409, 410, 413-415, 418
- Rust, yellow, 19, 28, 46, 49, 65, 79, 127, 136, 144, 168, 171, 198, 212, 229, 240, 248, 253, 273, 275, 282, 299, 306, 368, 418
- Rye, 7, 9, 19, 20, 23, 35, 37, 39, 42, 49, 50, 66, 67, 76, 82, 85, 86, 94, 109, 116, 119, 121, 125, 136, 148, 151, 173, 175, 176, 248, 252, 273, 274, 277, 281, 284, 287, 291, 302, 306, 308, 312-315, 319, 322, 323, 327, 329, 336, 337, 339, 340, 343, 350, 353, 354, 399, 400
- Rye, field weed, 151, 161, 162
- SERADELLA, 45, 327
- Shabdar, 175
- Smut, 49, 148, 273, 372, 374, 399, 409, 410, 413, 416
- Smut, damp, 415
- Smut, loose, 16, 109, 127, 198, 212, 355, 372, 373, 415
- Smut, stinking, 127, 137, 198, 212, 355, 373
- Smut, stem, 413-415
- Sorghum, 187, 239, 243, 422
- Spelt, 24, 42, 56, 57, 116, 260, 272-275, 285, 286
- Spurge, 194
- Soya, 82, 239, 240, 243, 245, 348
- Snapdragon, 353
- Sugar cane, 44, 78, 400
- Sugar beet, 260, 277, 281-283, 300, 302, 313, 359, 366, 369, 388, 418
- Sunflower, 308, 313, 319, 332

- Saghyz (*Scorozonera tau saghyz*), 33
- TEA, Paraguayan, 385
- Tobacco, 359
- Trigonella, 192
- Turnip, 36, 353, 420
- VETCH (*Pannonskaia*), 312
- Vetch, sown, 20, 23, 35, 45, 85, 102
- Vigna Chinese beans, 61, 240
- Vine, 45, 85, 218, 235
- WALNUT, 155, 156, 159, 175
- Watermelon, 40
- Wheat, 7, 8, 11, 15, 19, 20, 22-25, 29, 30, 35-39, 41-43, 45-47, 49, 51-53, 57, 61, 62, 66, 71, 75, 76, 79, 82, 85-88, 94, 97, 102, 109, 114, 121, 125, 127, 129, 134, 136, 141, 144, 147, 148, 151, 153, 156, 158, 173, 175, 177, 178, 180, 182, 184, 185, 187, 189, 190, 192, 195-197, 212, 216, 223, 229, 235, 236, 239-243, 245, 246, 248, 252, 253, 256, 257, 259-261, 266, 268, 270, 272-274, 277, 281, 282, 285-289, 291, 299, 300, 302, 306, 312-314, 319, 321-323, 327, 329, 331, 332, 336, 337, 340, 344, 348, 350, 352, 354, 357-359, 361, 366, 367, 373, 374, 382, 388, 393, 400, 401, 406, 408-410, 413-418, 420, 422 426
- * Wheat, club, 109, 136, 144, 162, 171, 172, 176, 178, 248, 259, 355, 373, 401
- Wheat, English, 76, 109, 127, 135, 142, 195, 198, 215, 239, 248, 272-274, 289, 422
- Wheat, Georgian, 113
- * Wheat, hard, 28, 36, 42, 54, 66, 72, 98, 109, 121, 125, 132-134, 140-142, 180, 181, 192, 197, 212, 215, 216, 218, 222, 235, 248, 260, 264, 268, 306, 308, 312, 319, 332, 339, 366, 369, 401, 405, 408, 413, 417, 425
- Wheat, Macha, 68
- Wheat, one grained, 42, 71, 72, 109, 110, 116, 127, 136, 137, 260, 270, 272-275
- Wheat, Persian, 15, 37, 46, 132, 134
- Wheat, Polish, 218
- Wheat, round grain, 54, 190
- * Wheat, soft, 16, 28, 38, 41, 66, 72, 109, 110, 121, 122, 127-129, 134, 135, 137, 138, 140, 142, 144, 147, 154, 158, 162, 167, 178, 184, 197, 201, 212, 219, 235, 248, 253, 259, 260, 264, 266, 268, 270, 272, 273, 275, 287, 292, 302, 306-308, 312, 314, 322, 339, 343, 367, 369, 374, 382, 388, 393, 400, 401
- Wheat, spelt, 51
- Wheat, Timofeev, 15
- Wheat, two grained, 42, 49, 52-57, 68, 116, 134, 136, 137, 144, 192, 260, 261, 268, 270, 272-275
- Winter rape, 353

* Also sometimes referred to as dwarf, durum and common wheat, respectively.

INDEX OF LATIN PLANT NAMES

(The page numbers indicated in this index are those of the Russian original and can be found in the left hand margin of the printed translation. Due to technical reasons, however, figures, photographs, and tables have, in some cases, been printed on one of the adjoining pages.)

- Aegilops* L. 13, 20, 94, 102, 109, 136
Albizia Julibrissin Durazz. 114, 142
Andropogon ischaemum L. 147
Antirrhinum majus L. 353
Armeniaca vulgaris L. 175
Avena L. 20
Avena abyssinica Hochst. 195, 206
Avena brevis Roth 45, 264, 273
Avena brevis Roth var. *turgida* Vav. 71
Avena byzantina C. Koch 16, 45, 109, 212, 261, 373, 374, 399, 416, 425
Avena sativa L. 11, 49, 57, 58, 261, 292, 315, 319, 343, 354, 425
Avena sativa L. var. *nuda* 258
Avena strigosa Schreb. 45, 261, 264, 273
Avena Vaviloviana Malz. 195

Berberis vulgaris L. 147
Brassica campestris L. 175
Brassica carinata A. Br. 196
Bromus inermis Leyss. 42

Camelina sativa Crantz. 71
Cannabis ruderalis Janisch. 339
Ceratonia siliqua L. 218
Chenopodium quinoa Willd. 405
Cicer L. 20
Cicer arietinum L. 65, 105, 139, 164, 209, 262
Cinnamomum zeylanicum Nees 187
Cocos nucifera L. 187
Coffea arabica Benth. 187
Colletotrichum linicola Peth. et Laff. 212, 399
Corchorus capsularis L. 187
Corchorus olitorius L. 187
Cucurbita moschata Duchesne 390
Cyathea dealbata Sw. 419
Cyathea medullaris Sw. 419

Dicksonia fibrosa Col. 419
Dicksonia squarrosa Sw. 419
Dracaena Vand. 419

Elettaria cardamomum Salib. 187
Fleusine corusana Gaerth. 187
Eruca sativa Lam. 175
Erysiphe graminis DC. 46
Eucalyptus globulus Labill. 192
Euphorbia abyssinica Gmel. 194,
- Faba Pliniana* (Trabut) Murat 216
Festuca sulcata L. 147
Fusarium nivale Ces. 38

Gossypium barbadense L. 11
Gossypium herbaceum L. 11, 57, 168
Gossypium hirsutum L. 11, 168

Haynaldia Schur. 94
Helminthosporium Link. 134
Hordeum distichon L. var. *abyssinicum* Sér. 203
Hordeum distichon L. var. *daghestonica* Vav. et Orb. 126
Hordeum distichon L. var. *deficiens* Steud. 203
Hordeum distichon L. var. *erectum* 326
Hordeum distichon L. var. *nigripallidum* Reg. 202
Hordeum distichon L. var. *nutans* Schübl. 138, 158, 277, 339
Hordeum distichon L. var. *nutans* Schübl. subvar. *colchicum* Reg. 128, 147
Hordeum distichon L. var. *syriacum* Vav. et Orl. 107
Hordeum distichon L. var. *zeocritideficilus* Vav. 204
Hordeum hexastichum var. *parallelum* Körn. 147
Hordeum sativum Jessen 11, 20
Hordeum sativum Jessen ssp. *aethiopicum* Vav. 197
Hordeum spontaneum C. Koch 98, 106, 119, 136, 158
Hordeum vulgare L. var. *brachyatherum* Körn. 243
Hordeum vulgare L. var. *breviaristatum* Vav. 241
Hordeum vulgare L. var. *coeleste* L. 172, 255
Hordeum vulgare L. var. *dundar-beyi* Zhuk. 23
Hordeum vulgare L. var. *eurylepis* Körn. 205
Hordeum vulgare L. var. *nigritonsum* Körn. 242
Hordeum vulgare L. var. *pallidum* Sér. 107, 202, 312, 326, 339
Hordeum vulgare L. var. *subpyramidatum* Orl. 243

Juglans regia L. 175

- Lathyrus* L. 20
Lathyrus sativus L. 165, 262
Lens Adans. 20
Lens esculenta Moench. var. *abyssinica* (Hochst.) Al. 208
Lens esculenta Moench. var. *afghanica* Bar. 63
Lens esculenta Moench. var. *indica* Al. 64
Lens esculenta Moench. ssp. *macrosperma* (Baumg.) Bar. var. *nummularia* Al. 221
Lens esculenta Moench. ssp. *microsperma* (Baumg.) Bar. var. *vulgaris* (Al.) Bar. 323
Lens esculenta Moench. var. *subnummularia* Bar. 115
Lens esculenta Moench. var. *syriaca* Bar. 104
Linum L. 20
Linum crepitans Dum. 71
Linum usitatissimum L. 15, 20, 26, 66, 67, 114, 166, 168, 173, 174, 185, 187, 225, 226, 320
Lolium temulentum L. 142
Lupinus L. 45

Mangifera indica L. 187
Melampsora lini (Ehrenb.) Lév. 212
Melo Adans. sectio *Bubalion* Pang. 51
Morus L. 175
Musa ensata Gmel. 197

Nothofagus cliffortioides Oerst. 419
Nothofagus truncata 419

Olea europaea L. 218
Ornithopus sativus Brot. 45
Oryza sativa L. 187

Papaver somniferum L. 178
Parrotia persica (DC) C. A. M. 114, 142
Pennisetum glaucum R. Br. 187
Phoenix dactylifera L. 235
Phormium tenax Forst. 419
Pisum Tourn. 20, 109
Pisum abyssinicum Braun. 195, 196
Pisum elatius (M. B.) Stev. 102
Pisum fulvum Sibth. et Sm. 98, 102
Pisum humile Boiss. 98
Pisum sativum L. 62, 103, 161, 219, 293, 320
Poa alpigena (Fries.) Lindm. 65
Poa alpina L. 65
Polyspora lini Laff. et Peth. 212, 399
Puccinia glumarum Eriks. et Henn. 46
Puccinia graminis Pers. 46
Puccinia triticea Eriks. 46

Saccharum officinarum L. 400
Salix Humboldtiana Willd. 385
Secale L. 20
Secale ancestrale Zhuk. 109
Secale cereale L. 19, 67, 109, 119, 151, 161, 306, 312, 315, 343
Secale chaldicum Fed. 116
Secale daralagesi Tum. 116, 136

Secale dighoricum Vav. 116
Secale fragile M. B. 42
Secale montanum Guss. 109
Secale silvestre Host. 42
Secale Vavilovii Grossh. 42, 116, 136
Sorghum vulgare Pers. 239
Spirea hypericifolia L. 147
Stipa pulcherrima C. Koch 147, 344

Theobroma cacao L. 400
Trifolium resupinatum L. 175
Triticum L. 20
Triticum carthlicum (Vav.) Nevski 16
Triticum compactum Host. 52, 53, 136, 344, 354, 413—415
Triticum dicoccoides Körn. 13, 17, 18, 98, 116, 136
Triticum dicoccum Schübl. 42, 49, 55, 56, 268, 272
Triticum durum Desf. 27, 66, 125, 133, 140, 181, 215, 268, 413, 414
Triticum durum Desf. var. *horanicum* Vav. 66, 98
Triticum durum Desf. var. *hordeiforme* (Host.) Körn. 270
Triticum georgicum Dek. 113, 114, 121, 127
Triticum macha Dek. et Men. 66, 68, 80, 114, 121, 127
Triticum monococcum L. 42, 71, 72, 272
Triticum persicum Vav. 15, 16, 37, 46, 66, 116, 126, 129, 132, 147
Triticum persicum Vav. var. *fuliginosum* 37
Triticum polonicum L. 218
Triticum spelta L. 42, 51, 151, 272, 274
Triticum speltiforme Seidl. 151
Triticum sphaerococcum Perc. 52—54, 190
Triticum Timopheevi Zhuk. 15, 80, 114, 116, 121, 127
Triticum turgidum L. 50, 66, 71, 76, 109, 127, 135, 140, 142, 215, 239, 248, 264, 268, 269, 272—274, 289, 422
Triticum turgidum L. ssp. *abyssinicum* Vav. 195, 198
Triticum urartu Thum. 136
Triticum Vavilovii (Thum.) Jakubz. 80, 136
Triticum vulgare Vill. 11, 19, 31, 106, 110, 122, 128, 135, 138, 154, 157, 158, 184, 201, 219, 266, 292, 306, 307, 393, 413
Triticum vulgare Vill. var. *erythrospermum* Körn. 339
Triticum vulgare Vill. var. *ferrugineum sibiricum* Flaks. 340
Triticum vulgare Vill. var. *fuliginosum* Al. 337, 339
Triticum vulgare Vill. subsp. *irano-turkestanicum* Vav. 140
Triticum vulgare Vill. var. *lutescens* Al. 339, 340
Triticum vulgare Vill. var. *mitturum* Al. 339
Triticum vulgare Vill. var. *oasicolum* Ducl. 235
Triticum vulgare Vill. gr. *persicoides* Vav. 134, 147

- Triticum vulgare* Vill. supsp. *sinicum* Vav. 28
Tropaeolum tuberosum Ruiz. et Pav. 405
Ullucus tuberosus Caldas 405
Vavilovia An. Fed. 116, 136
Veronica L. 419
Vicia ervilia Willd. 175, 261
Vicia faba L. 134, 142, 220
Vicia faba L. ssp. *europaea* f. *viridissima* (Alef.) Murat. 293
Vicia faba L. ssp. *maxima* f. *macrosperma* (Alef.) Murat. 221
Vicia faba L. ssp. *paucijuga* (Alef.) Murat. f. *daghestanica* Murat. 132
Vicia faba L. ssp. *septrionalis* f. *ianthina* Murat. 328
Vicia monanthos Desf. 261
Vicia pannonica Jacq. 302
Vitis Berlanderi Planch. 45
Vitis labrusca L. 45
Vitis rupestris Scheele 45
Zea mays L. 11
Zingiber officinale Rosc. 187

INDEX OF GEOGRAPHICAL NAMES

NOTE. The page numbers indicated in this index are the Russian ones and can be found in the left hand margin of the printed translation. The asteriks denote the printed translation page number for references to figures, photographs and tables which appear at the end of each chapter.

- | | |
|---|---|
| ABBE, 193 | Alagez, 89, 135, 136 |
| Aberdeen, 296 | Alai Range, 90, 150, 174, 175, 178 |
| Abkhazia, 19, 20, 28, 39, 110, 114 | Alashan, 252 |
| Adana, 97, 109, 211 | Alaska, 93, 340, 359, 361 |
| Adi-Ugri, 197 | Alazan, 134 |
| AddisAbaba 44, 192, 195, 196, 198, 199, 206 | Alazan Valley, 89 |
| Adigey, ASSR, 144 | Albania, 91, 270 |
| Adzharia, 89, 110 | Albany, 419 |
| Aegean Islands, 91, 207, 229, 252 | Alberta, 357-359, 362, 366 |
| Afghanistan, 6, 12, 23, 38 - 41, 43, 46, 47, 50, 52, 61-63, 75, 147, 148, 151, 154, 157, 158, 161, 162, 166, 170-173, 175, 207, 216 | Albury, 421 |
| Africa, 5, 26, 82, 409 | Aldan, 344 |
| Africa, East, 86 | Aleppo, 97 |
| Africa, North, 87, 91, 215-217, 235 | Alexandria, 230 |
| Africa, South, 12, 19, 53, 89, 93, 354, 410, 413, 422 - 427 | Algeria, 16, 54, 60, 61, 72, 91, 207, 211, 212, 216 - 218, 226, 233, 235, 352 |
| Agra, 188 | Alma-Ata, 177 |
| Ain Draham, 217 | Alps, 91, 270, 272, 273, 276, 299, 300 |
| Akhalkalaki, 57, 131 | Alps, Australian, 417 |
| Akhty, 130 | Altai, 92, 336 - 339 |
| Akmolinsk, 334 | Altaiskaya, 337 |
| Alabama, 374, 378 | Altiplano, 405 |
| | Amarillo, 377 |

- Amazon, 386, 389
- Amenia, 364
- America, 5, 50, 72
- America, Central, 6, 61, 356, 374
- America, Latin, 6
- America, North, 82, 87, 93, 274, 354, 356, 366, 382
- America, South, 82, 87, 93, 354, 382, 387
- Amga, 344
- Amman, 98
- Amu-Darya, 66, 90, 147, 154, 163
- Amur, 93, 344, 349
- Amur Region, 344
- Anatolia, 94, 97, 103, 108 - 110, 114, 116
- Ancash, 406
- Andalgala, 384
- Andalusia, 207, 399, 401, 408
- Andes, 405
- Andizhan, 162
- Anhwei, 91, 236, 243, 251
- Ankara, 108
- Ankoher, 192, 206
- Apennine Peninsula, 86, 207, 266
- Apsheron, 89, 119, 141
- Apulia, 207
- Aquitaine, 281-283
- Arabia, 42, 90, 191, 192, 222
- Araks, 89, 121
- Arctic area, 350, 352, 353
- Arequipa, 406, 407
- Argentina, 6, 11, 12, 19, 32, 53, 58, 82, 87, 93, 376, 382, 385, 388, 394, 399 - 401, 405
- Argun, 344
- Arizona, 373, 374
- Arkansas, 374
- Arkhangelsk, 37, 352
- Arkhangelsk Region, 35, 65, 326
- Armagh, 297
- Armenia, 16, 37, 42, 89, 115, 116, 121, 122, 126, 131, 134 - 139, 144
- Armenia, Lesser, 109, 136
- Ashkhabad Oasis, 154
- Ashville, 378
- Asia, 5, 26,
- Asia, Northwestern, 15, 23, 85-89, 94, 114, 248, 252, 272
- Asia, Central, 66, 172, 173, 280
(also Central Asia)
- Asia, Eastern, 36, 37, 235
- Asia Minor, 6, 12, 28, 89, 91, 94, 103, 207, 229, 269
- Asia, Southeastern, 82, 235, 236
- Asia, Southwestern, 42, 55, 61, 62, 75, 87
- Asiatic part of USSR, 178
- Askania Nova, 102
- Astara, 90, 120, 141
- Astrabad, 90, 141
- Asturias, 91, 260, 272, 273
- Aswan, 230

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

Atacama, 400	Banat, 92, 274, 300, 302
Athens, 210	Barabinsk, 332
Atlas mountains, 91, 215-217	Barguzin, 346, 347
Australia, 11, 12, 19, 53, 58, 82, 87, 93, 189, 192, 269, 354, 408 - 422, 424, 426	Barnaul, 332, 335
Australia, Southern, 408, 413, 417, 418	Bashkiria, 308, 313
Australia, Western, 417	Basque Provinces, 91, 260, 272, 273
Austria, 91	Batna, 216, 217
Azerbaijan, 19, 28, 32, 89, 98, 115, 116, 121, 125, 126, 129, 130, 132, 134, 140, 141, 144	Batumi, 119
BADAKHSHAN, 38, 51, 66, 90, 173-177	Bavaria, 71, 92, 270, 272, 274
Baden, 92, 270	Bayut-Gemal, 98
Baghdad, 101	Beaver Lodge, 358
Bagneres-de-Bigorre, 274	Belakhsia, 224
Bahia Blanca, 400	Belem, 390
Baikal, 339, 340, 343	Belgium, 92, 272, 277, 281 - 284
Bairan-Ali, 162	Belgrade, 271
Baksan, Canyon, 120, 147	Belokhan, Area, 134
Baku, 142	Bendigo, 421
Bakvii, Desert, 40, 170	Bengal, 187
Balashov Region, 308	Bergen, 299
Balkan Mountains, 299, 300	Berlin, 288
Balkan, Peninsula, 86, 91, 268, 271	Berne, 273, 276
Balkh, 157	Beshri, 13
Baltford, 362	Bezenchuk, 311
Baltistan, 176, 177	Bihar, 187
Baluchistan, 52, 90, 181, 190	Blisk, 332, 335, 336
Bamian, Valley, 175	Bikaner, 186
	Bilbao, 272, 274
	Birmingham, 378
	Birobidjan, 348

- Biskra, 216
- Bismark, 364
- Black Sea, 270, 300
- Black Sea coast, 36, 119
- Blagoveshchensk, 344, 348, 350
- Blue River, (Yangtse), 242
- Blumenau, 402
- Bogustan, 149
- Bokovoi, Range, 129, 147
- Bolivia, 6, 93, 382, 390 - 392, 395 - 397, 405 - 407
- Bologna, 267
- Bombay, 185
- Bordeaux, 284
- Bosnia, 271
- Brandon, 362
- Brazil, 6, 78, 83, 84, 87, 93, 382, 386, 389, 390, 399, 400, 402, 403
- Bredasdorp, 427
- Brest, 284
- Bretagne, 281-283, 288
- Brno, 280, 316
- Brookings, 364
- Bucharest, 303
- Budapest, 301
- Buenos Aires, 383, 394
- Buinaksk, 142
- Bukhara, 158
- Bulgaria, 91, 92, 268, 270, 299, 301, 302
- Bureya, 344
- Burma, 242
- Buryat-Mongolia, 19, 65, 92, 253, 343, 347
- Byelorussia, 323
- Belostok 322
- CAIRO, 230
- Cajamarca, 406 - 407
- Calabria, 207
- Caledon, 423
- Calgary, 362
- California, 373, 374
- Cambridge, 295
- Campo-major, 264,
- Canada, 6, 11, 12, 19, 32, 41, 53, 58, 72, 87, 93, 189, 332, 340, 354, 356 - 366, 410, 421
- Cantabria, 91
- Cantabrian Mountains, 260, 272
- Cape Province, 93, 422 - 424, 426, 427
- Capetown, 423, 427
- Carabia, 301
- Carolina, 374, 378
- Carpathians, 92, 270, 273, 278, 279, 299, 300
- Casablanca, 211
- Casas Grandes, 380
- Casbah-tadl, 238
- Cascade Mountains, 369
- Caspian area, 89, 140
- Caspian Coast, 36, 116

- Caspian Sea, 140, 141
- Catamarca, 382
- Catania, 212, 232
- Catta-kurgan, 151
- Caucasus, 6, 12, 15, 85 - 87, 89, 94, 115, 116, 119, 120, 122, 124 - 126, 134, 252, 272
- Caucasus Northern, 12, 19, 35, 41, 47, 53, 87, 90, 92, 115, 122, 126, 144 - 147, 229, 300, 308, 309
- Caucasus, Small, 116, 121, 132
- Central Asia, 6, 12, 38, 46, 47, 49-52, 57, 76, 79, 86, 141, 147, 148, 151, 154, 157, 158, 162, 175, 167, 168, 177, 178
- Central Chernozem Regions, 6
- Central Province, 185, 188
- Cerro de Pasco, 406, 407
- Ceylon, 187
- Chaman, 190
- Changchum, 256
- Chateauroux, 284
- Chefoo, 244
- Chegem Canyon, 130, 147
- Chekian, 243
- Chelyabinsk, 331 - 333
- Chelyabinsk Region, 331
- Chengtu, 246
- Cherat, [Herat], 183
- Chernovtzy, 278
- Chichen Itza, 375, 376
- Chile, 6, 12, 87, 93, 382, 400, 401, 405
- Chiloe, 401
- Chimkent, 177, 179
- China, 8, 12, 15, 19, 28, 37, 45, 50, 52, 61, 62, 65, 66, 79, 81, 91, 148, 178, 235, 236, 239 - 248, 253, 258, 259
- China, Northern, 31, 239, 240
- China, Northeastern, 253, 256, 257, 260, 261
- China, Southeastern, 243, 251
- Chita, 340, 343 - 345
- Chita Region, 344
- Chitral, 172, 175, 176
- Chkalov, 310
- Christchurch, 422
- Chu, 178
- Chu Highway, 337
- Chungking, 246
- Cilicia, 23
- Cis-Ural Region, 308
- Cleveland, 418
- Coimbra, 261, 264
- Colombia, Rep., 23
- Colonia, 388
- Colorado, 369
- Columbia, 379
- Constantine, 216, 217
- Cootamundra, 421
- Copenhagen, 294
- Coquimbo, 405
- Cordillera, 82, 388 - 400

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

- Cordoba (Spain), 260, 261
Cordoba (Argentina), 400
Cracow, 315
Crete, 6, 86, 91, 207, 217, 222, 231
Crimea, 11, 92, 299, 300, 302, 304, 367
Cuba, 6
Curitiba, 402
Curitibanos, 402
Cusco, 83, 398, 306, 307
Czechoslovakia, 92, 270, 275, 280, 313-316
Cyprus, 6, 59, 86, 91, 207, 217, 221, 222, 232
DAGHESTAN, 16, 32, 37, 46, 47, 66, 71, 87-89, 116, 121, 122, 126, 129-132, 134, 140-142, 144
Dakota, North, 364
Dakota, South, 364
Dal'niĭ, 252, 253
Damascus, 95, 103
Damascus, Oasis, 235
Danube, 300, 302
Daralage Range, 89, 135
Dead Sea, 97
Deccan, 46, 185, 189
Deccan Plateau, 185
Denizli, 115
Denmark, 6, 51, 52, 92, 288, 420
Derbent, 6, 12, 142
Dġgori, 21, 116
Dnepropetrovsk, Region 308
Don, 300
Dorokhoi, 303
Dublin, 296, 297
Dunedin, 422
Dzhambul, 179
EAST KAZAKHSTAN REGION, 336
Edinburgh, 296
Edmonton, 262
Eekloo, 282
Egypt, 47, 48, 50, 52, 86, 91, 213-215, 219, 222-230, 425
Elbrus, 120, 147
Elenovka, 131
El Paso, 377
England, 52, 61, 71, 72, 82, 87, 289, 293, 297, 421
Eniseĭsk, 342
Erfurt, 278
Eritrea, 6, 12, 86, 90, 192, 197, 200
Erivan, 89, 135, 136
Es Salt, 17
Estonia, 92, 287
Ethiopia, 6, 12, 15, 23, 26-28, 32, 35-37, 43, 44, 56, 66, 79, 86, 90, 191, 206, 208, 209, 225, 248, 352
Etszin-Gol, 253
Euphrates, 96-98
Europe, 5, 26, 47, 82, 266, 274, 406
European USSR, 19, 35, 37, 38, 41, 76, 92, 95, 148, 168, 173, 178, 180, 196, 259, 277, 281, 291, 314, 319-321, 323-325, 327, 330, 340, 357

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

- Europe, Central, 87, 91, 184, 270
- Eastern, 87, 92, 277, 313, 321
 - Northwestern, 277
 - Southern, 87, 91, 135, 239
 - Western, 12, 19, 35, 52, 72, 91, 270, 277, 281
- FAIRBANKS, 359, 361
- Far East (Soviet), 12, 47, 76, 93, 349, 351
- Fergana, 162, 178
- Fergana Range, 178
- Fergana Valley, 154
- Fez, 235
- Fich, 194, 206
- Finland, 37, 38, 51, 92, 287, 289-291, 298, 299
- Foix, 274
- Fort Chippewayan, 358
- France, 6, 72, 91, 92, 264-266, 274, 277, 281-284, 288, 425
- Fukien, 248
- GALEANA, 380
- Galicia, 91, 260, 272, 273
- Ganges, River, 45, 178
- Garm, 149
- Garonne, 281
- Gazimur, 344
- Geneva, 276
- Georgia, 15, 16, 37, 57, 58, 66, 68, 89, 110, 113, 115, 126-134, 260
- Georgia, USA, 374, 379
- Germany, 6, 45, 51, 52, 71, 72, 92, 270, 274, 275, 277-279, 281, 284-289
- Ghilan, 90, 141
- Giza, 213, 227
- Glasgow, 297
- Gobi, 252
- Gondar, 27, 44, 197, 198, 206
- Gori, 129
- Gori Area, 58
- Gorki Region, 327
- Gorni Moravska, 280
- Gorno-Altaiisk, 336, 337
- Gorno-Altaiisk, Autonomous Region, 336
- Gorno Badakhshan, Autonomous Region, 46
- Granada, 210
- Grass Valley, 371
- Graz, 88
- Great Basin, 93, 369
- Great Britain, 92, 277, 288
- Great Chinese Depression, 91, 241, 242, 245
- Great Plain, 41, 366
- Great Valachian Plain, 92, 299, 302
- Greece, 45, 48, 59, 91, 94, 207, 210, 229, 231, 259, 258-271, 413
- Greenwich, 294, 295
- Groningen, 294
- Grozny, 146
- Grozny Region, 144
- Guadalajara, Mexico, 381

- Guatemala, 23
- Gunt, 159, 160
- Gura, 223
- HAIFA, 211
- Hakodate, 70, 254
- Hallburn, 421
- Hamadan Road, 33
- Hamburg, 288
- Hankow, 251
- Hanover, 288
- Harbin, 256
- Hari River, 50, 154
- Harrar, 27, 43, 192, 194, 196, 198, 206
- Havre, 365
- Hays, 366, 367
- Hebron, 99, 101
- Heilungkiang, Manchuria, 91, 256
- Helena, 372
- Helsinki, 290
- Herat Oasis, 157 (see also Cherat)
- Himalayas, 50, 90, 167, 168, 172, 174, 176, 180, 181
- Hindu Kush, 39, 43, 90, 148, 171, 172, 174, 175
- Hindustan, 90, 180, 182
- Hissar Range, 90, 174, 175
- Hobart, 419
- Hokkaido, 69, 70, 73, 74, 77, 247, 249, 250, 254
- Holland, 6, 92, 277, 288, 292, 294-296, 425
- Homs, 95,
- Honan, 91, 236, 241
- Honshu, 246, 247, 254
- Hopeh, 236, 244, 259
- Hauran, 13, 14, 96, 98
- Horsham, 421
- Huancavelica, 406
- Huancayo, 406
- Huesca, 244
- Hungary, 72, 92, 270, 299-302
- Hunan, 243
- Hupei, 91, 241, 243, 251
- Hyderabad, 185, 188
- IAILA, 300
- Iasi, 303
- Idaho, 369
- Ichang, 251
- Igarka, 36
- Irkutsk Region, 339
- Illimani, 390
- Illinois, 93, 367, 368
- India, 8, 12, 19, 32, 35-37, 42, 45, 49, 50, 52, 61, 64, 65, 75, 86, 87, 171, 180, 181, 189, 207, 248, 413, 425
- India, Central, 90, 181, 185, 187, 188, 190
- Indian Head, 364
- Indiana, 367
- Indo-China, 189, 242
- Indonesia, 82, 189
- Indore, 188

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

Indus River, 176	Jebel, 191
Innsbruck, 276	Jehol, 257
In Salakh, 217	Jerash, 100
Iowa, 367	Jersey, 282
Iran, 6, 12, 22, 29, 30, 33, 46, 47, 49, 50, 90, 94, 120, 121, 140, 141, 147- 149, 151, 154, 157-161, 162, 164, 168, 178, 180	Jerusalem, 101
Iran, Plateau, 121, 144	Jihlava, 280
Iraq, 101	Johannesburg, 427
Ireland, 92, 277, 288, 296, 297	Junin, 406
Irkeshtam, 34	KABARDA, 120, 144, 147
Irkutsk, 341, 343	Kabansk, 347
Irkutsk Region, 339	Kabilia, 91, 215 - 217
Ironwood, 114, 142	Kabul (River), 157
Isfahan, 162	Kabul (Town), 40, 90, 171, 175, 184
Ishim, 332	Kagoshima, 61, 154
Iskem, 150	Kaifeng, 241
Ispaisai, 155	Kakh area, 134
Issyk Kul, 177, 178	Kakhetia, 121, 127, 129, 132, 134
Italy, 11, 71, 91, 135, 219, 221, 226, 259, 267, 268, 273, 302, 382, 399, 405, 425	Kalgan, 253
Ithaca, 369, 370	Kalahari, 423
Iukal (Belgium), 282	Kalingiri, 421
Ivanovo, 324	Kalinin Region, 323
Ivanovo Region, 314, 322, 323	Kaliningrad Region, 92, 287
Iseo, 264	Kama Region, 68
JACA, 274	Kamennaya, Steppe, 12, 311
Japan, 6, 12, 19, 23, 37, 52, 61, 62, 69, 70, 73, 74, 77, 82, 91, 239, 240, 243, 245-250, 254	Kamyshin, 310
	Kansas, 38, 366, 367
	Kansu, 91, 240, 242
	Kansk, 340
	Kara-Kalpak, 90, 147

- Kara-Kum, 165
 Kara-Tau, 33
 Karelian SSR, 35
 Karo, 108
 Karroo, 423
 Kartalin, Region, 132
 Kashgar, 34, 66, 90, 147, 167 - 169, 171
 Kashmir, 32, 90, 181, 182, 189
 Kastamonu, 114
 Katanning, 421
 Katta-Kurgan, 151
 Kaunas, 290
 Kavalla, 269
 Kazakhstan, 33, 90, 147, 177 - 180, 331, 336
 Keiling, 176
 Kem, 352
 Kentucky, 366
 Keren, 197
 Khabarovsk, 349 - 351
 Khabarovsk Territory, 344
 Khakas Autonomous Region, 336
 Khan Yunis, 112
 Khanka, 349
 Kharkov, 12, 204
 Kharput, 108
 Khartoum, 230
 Kherson, Region, 102
 Khezari Road, 154
 Khibiny, 12, 36, 191, 352
 Khiva, 67, 167
 Khiva Oasis, 23, 57, 66, 90, 147, 163, 165, 167
 Khorezm, 6, 163
 Khorog, 175, 176
 Khotan, 66, 90, 147, 167, 171
 Khotsu, 251
 Khunzakh, 131
 Khurasan, 151
 Kiakhta, 343, 346
 Kiangsi, 91, 241, 243
 Kiangsu, 236, 243, 251
 Kiev, 317
 Kirgizia, 90, 147, 178 - 180
 Kirin, 91, 256, 257
 Kirov, 331
 Kirov Region, 327
 Kishinev, 304
 Kobdo, 252, 253, 256
 Kola, Peninsula, 12, 36, 352
 Komi ASSR, 35, 327
 Kopet-Dagh, 15
 Korea, 6, 91, 239, 245, 247
 Kosh-Agach, 337
 Kosh-Daria, 170
 Kostroma, 330
 Krasnodar, 309
 Krasnodar, Territory, 87, 118, 144, 308, 367
 Krasnoyarsk, 341-343

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

- Krasnoyarsk, Territory, 336, 339
- Krasnyi-Kut, 12, 180
- Krasnyi-Vodopad, 151, 152, 180
- Kuban, 6, 76, 87
- Kuf, 156
- Kuibyshev, 310
- Kuibyshev, Region, 308, 313
- Kuku-khoto, 253
- Kurgan, 332, 333
- Kuro-siwo, 245
- Kursk, 315
- Kursk Region, 313
- Kushka, 152
- Kustanai, 334
- Kutaisi, 127 - 129
- Kuenlun, 167, 172
- Kweichow, 91, 242, 243, 246
- Kweiyang, 246
- Kyoto, 254
- Kyuhu, 246, 254
- Kyzyl-Kum, 165
- LADAKH, 172, 176
- Lagos, 212
- Lamanch (Spain), 260, 261
- Lambayeque, 406
- Lansing, 369
- Lander, 372
- La Paz, 406, 407
- Larisa, 210, 268, 269
- Latvia, 92, 287
- Launceston, 419
- Lausanne, 273, 276
- Lechkum, 127, 128
- Lena, 344
- Leninakan, 131
- Leningrad, 12, 37, 38, 76, 291, 325
- Leningrad, Region, 47, 323, 327
- Lenkoran, 19, 90, 94, 114, 120, 121, 126, 141 - 144
- Leon, 380
- Les Chotts, 217
- Lethbridge, 357
- Liaotung, 91, 257
- Libya, 222, 235
- Lima, 406
- Lincoln, 366, 367
- Lisbon, 261, 264
- Lithuania, 92, 287
- Liuan, 242
- Lombardia, 91, 266, 268
- London, 294, 295
- Lorient, 284
- Lund, 294
- Luxor, 224
- Lwow, 316
- Lyon, 264
- MACEDONIA, 91, 268 - 270
- Madison, 370

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

- Madras, 187
- Madrid, 263
- Maikop, 124, 245
- Maimana, 173
- Main Caucasian Range, 89, 116, 121, 127, 129, 132, 134, 138, 140, 300, 308
- Makhachkala, 142
- Malaga, 210
- Malmesbury, 423, 427
- Malta, 207
- Manchuria, 91, 245, 256, 257, 259
- Manhattan, 366, 367
- Manitoba, 357, 359, 362, 366
- Mantua, 267
- Marburg, 278
- Mardakiany, 142
- Mariette, 370
- Maritime Region, 344, 349
- Maritza, 91, 268
- Marrakesh, 216, 217, 235, 237
- Maryland, 374
- Mazandaran, 90, 141
- Mazar-i-Sharif, 157
- Mediterranean, 259, 266, 382, 401
- Mediterranean countries, 6, 12, 16, 19, 32, 35, 36, 42, 52, 61, 64, 75, 82, 86, 87, 90, 207, 209 - 212, 248, 259, 260, 266, 382, 401
- Meimana, 151
- Melbourne, 417, 419
- Memphis, 368
- Mercedes, 394
- Merzifon, 108
- Mersin, 109
- Merv Oasis, 154
- Mesopotamia, 6, 50, 94, 107
- Mexico, 6, 11, 23, 87, 93, 231, 354, 374 - 376, 379, 380, 382
- Mexico City, 374, 381
- Mezeta, 260, 261
- Michigan, 369, 370
- Milan, 266, 267
- Miles City, 365
- Minnedosa, 362
- Minnesota, 369, 370
- Minsk, 324
- Minusinsk, 336 - 338
- Mississippi, 374
- Missouri, 366, 368, 379
- Mitskheta, 129
- Miuri, 183
- Moab, 371
- Modor, 43
- Moldavia, 92, 299, 302, 304
- Molotov, 330
- Molotov Region, 329
- Monastiraki, 271
- Mondy, 346
- Mongolia, 32, 91, 236, 252, 253, 255 - 258, 340, 344

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

- Mongolia, Inner, 91, 258
- Montana, 365, 369, 372
- Montevideo, 385, 394
- Montreal, 357, 360
- Moose Factory, 360
- Morocco, 72, 91, 207, 211, 215 - 218, 225, 235, 237, 238
- Moscow, 12, 37, 38, 76, 291, 324, 325
- Moscow Region, 47, 323, 328
- Mossel Bay, 327
- Mountainous Badakhshan, 38, 173
- Mountainous Karabakh, 89, 136, 137
- Mozdok, 146
- Mozdok Area, 53, 147
- Mudgee, 421
- Mugla, 114
- Mukden, 257
- Munich, 278
- Murgab, 157
- NAGPUR, 188
- Nakhichevan, 89, 121, 140
- Nalchik, 146
- Nanking, 243
- Nan-lin-shan, 243
- Nantes, 282
- Naples, 210
- Naryn, 336
- Naryn, 179
- Natal, 422
- Nebraska, 38, 366, 367
- Nelson, 422
- Nemerchi, 318
- Nerchinsk, 340, 343 - 345
- Nevada, 369, 371
- New Mexico, 373
- New South Wales, 400, 410, 415, 417, 418, 421
- New York, 369, 370
- New Zealand, 93, 282, 408, 419 - 423
- Nicosia, 59, 222
- Nikolaev, 305
- Nikolaevsk-on-the-Amur, 349
- Nile, 222, 225
- Nile, Blue, 193, 225
- Nile, White, 222, 225
- Norfolk, 379
- North West Frontier Province, 90, 181, 183, 184, 186
- Norway, 92, 289, 298, 299
- Novgorod, 327
- Novgorod Region, 323
- Novobad, 149
- Novo-baiazet, 131
- Novocherkassk, 12
- Novosibirsk, 331, 332, 335
- Novosibirsk Region, 331
- Novozybkov, 324
- Nukha 89, 129
- Nuernberg, 278

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

OB', 36	Palestine, 8, 17, 18, 89, 94, 97 - 103, 109, 111, 112, 211
Odessa, 305	
Ogden, 371	Pamir, 6, 66, 90, 151, 167, 172, 174, 175, 177
Ohio, 367	Pamir area, 50, 176
Oklahoma, 366, 374, 378	Pamir Station, 175, 176
Olekminsk, 348	Pamplona, 274
Omsk, 331, 333	Pangong, 176
Omsk, Region, 327, 331, 332	Para, 390
Ontario, 357, 360	Parana, 399, 400, 402
Ophir, 422	Paris, 282, 283
Oran, 216	Peking, 241, 244
Orange Free State, 423, 427	Peloponnese, 271
Ordos, 252	Perth, 419
Ordzhonikidze, 146	Penza Region, 313
Oregon, 369, 370, 372	Peru, 6, 50, 61, 83, 84, 93, 382, 397, 398, 405 - 408
Osijek, 301	Perugia, 75
Oslo, 296	Peshawar, 90, 181, 184, 186
Osetia, 116	Petropavlovsk, 331
Osetia, Northern, 21, 117, 118, 120, 144, 146, 147	Petrovsk-Zabaikal'skiĭ, 345
Osetia, Southern, 22	Philippines, 82
Otrada-Kubanskaya, 6, 12, 117	Philippolis, 269
Ottawa, 357	Pyatigorsk, 145
Oulu, 298	Pitsunda, 18
Oviedo, 274	Piura, 406
Oxford, 295	Pleven, 301
PACHUCA, 381	Poland, 92, 281, 287, 288, 290, 299, 313 - 316, 321 - 323
Padua, 267	Poltava, 30
Palermo, 210	Port Arthur, 360

Portland, 372

RACHA-LECHKHUMI, 89

Porto Alegre, 403

Rajasthan, 90, 181, 184, 186

Port Sudan, 320

Rampart, 359

Portugal, 71, 91, 207, 212, 259, 261,
264, 265, 382

Rawalpindi, 183

Red Basin, 91, 242, 246, 247

Potosi, 406

Red Sea, 191

Poznan, 290

Regina, 357

Prague, 280

Rhodes, 206, 207

Pretoria, 423, 427

Rhone, 91

Kama Region, 68

Ryazan, 320

Prince Albert, 358

Riff, 91, 215, 217

Prokhladnaya, 146

Riga, 290

Prut, 302

Rio Grande, 403

Przhewalsk, 177, 179

Rio Grande de Sol, 400

Pskov, 327

Rocky Mountains, 369

Pskov Region, 323

Rocky Range, 120, 147

Puerto Montt, 404

Rodchevo, 348

Puerto Rico, 6

Rome, 210

Pullman, 371, 373

Roshan, 51, 176

Poona, 405

Rostov-on-the-Don, 309

Punjab, 45, 90, 181, 184, 186, 190

Rostov Region, 87, 308

Puno, 406, 407

Rouen, 282

Pushkin, 6, 326

Roseburg, 372

Pyrenees, 91, 260, 270, 272, 274,
275, 281

Rupcha, 176

Pyrenees, Peninsula, 86

Rumania, 92, 278, 299, 302, 303

Quebec, 93, 357, 360

Rushan area, 156

Queensland, 408, 410, 417

SAFED, 18

Quenia, 260, 261

Sahara, 213, 216, 228, 235

Quetta, 190

Sayan, 92, 336 - 339

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

- Saint Paul, 369, 370
- Sakurajima, 61
- Salamanca, 263
- Saleng, 39
- Salonica, 268, 269
- Samarkand, 162
- Samarkand Oasis, 154
- Samsun, 114
- San, 191
- San Louis Potosi, 380
- Santa Catherina, 400, 402
- Santa Cruz, 376
- Santa Maria, 403
- Santander, 274
- Santa Fe, Argentina, 394
- Santa Fe, USA, 377
- Santiago, 401, 404
- Sao Paulo, 78, 87
- Sapporo, 254
- Saragossa, 260, 263
- Sarajevo, 271
- Saratov, 76, 310
- Sardinia, 6, 207
- Saskatchewan, 357 - 359, 362, 364, 365
- Saskatoon, 357, 362
- Savannah, 379
- Saxony, 92, 270, 274
- Scandinavia, 35, 277, 289, 290, 298
- Schwabia, 274
- Scotland, 296, 297
- Segavadem, 193
- Selenga, 252
- Semipalatinsk, 332, 334
- Seoul, 252, 253
- Setif, 60, 233
- Shadrinsk, 332
- Shakh dara, 159
- Shakhimardan, 150
- Shanghai, 243, 251
- Shansi, 91, 236, 240, 242
- Shantung, 91, 236, 241, 244, 259
- Shatilovo, 318
- Shemakha, 89, 129
- Shensi, 91, 236, 240, 242
- Shibarghan, 166
- Shikoku, 246
- Shizuoka, 74
- Shugnan, 51, 66, 176
- Shuntuki, 188
- Shusha, 137
- Sialkot, 186
- Siberia, 35, 36, 92, 252, 331, 352
- Siberia, Eastern, 32, 92, 253, 339 - 343
- Siberia, Western, 37, 42, 82, 92, 178, 180, 331 - 336, 361
- Sicily, 6, 60, 86, 207, 210, 232
- Sidi-bel-Abbes, 233
- Sierra Nevada (America), 369
- Sierra Nevada (Spain), 260
- Simferopol, 304

- Simonstown, 427
- Sinaia, 278
- Sind, 90, 181, 184
- Sinkiang, 6, 8, 34, 39, 90, 147, 151, 154, 157, 162, 167, 168, 178
- Sirsa, 186
- Sivantse, 252
- Smyrna, 114, 211
- Sophia, 271
- Sorell, 419
- Soviet-Baltic Republics, 38, 277, 281, 287
- Spain, 51, 61, 71, 91, 207, 210, 259 - 263, 272, 274, 382, 406, 408
- Splugen, 273
- Sretensk, 344, 347
- Srinagar, 182
- Stalingrad, 310
- Stalingrad Region, 308
- Staryĭ Smokovets, 280
- Stavropol, 12, 309
- Stavropol Territory, 87, 308, 367
- Stillwater, 378
- St. Louis, 368
- Stockholm, 298
- Strikharet, 303
- Stuttgart, 278
- Styr-Digora, 117, 118
- Sudan, 91, 222, 229
- Sukhumi, 12, 18, 123
- Sunpan, 52
- Sub-Polar Area, 76
- Sucre, 407
- Suliman, Mountains, 171
- Sultan Bakhva, 170
- Sumy, 318
- Suram Pass, 121, 129
- Surkhab, 149
- Suvalki, 290
- Sverdlovsk, 330
- Sverdlovsk, Region, 327
- Swanetia, 21
- Sweden, 6, 38, 51, 52, 61, 92, 288, 289, 291, 294, 298, 299
- Swift Current, 365
- Switzerland, 91, 264, 273
- Sydney, 417, 419
- Syria, 13, 14, 42, 66, 89, 91, 94 - 98, 103, 104, 106, 107, 109, 136, 235
- Syzran, 310
- Szechwan, 91, 236, 242, 245, 246
- Szeged, 301
- TABLE MOUNTAIN, 427
- Tacoma, 371, 372, 373
- Tadjikistan, 46, 90, 149, 155, 156, 159, 160, 175
- Tai-pan-fu, 242
- Taiwan, 6
- Takla-Makan, 167
- Talas Alatau, 150
- Tallin, 290

- Tamboy, 320
- Tambov, Region, 313
- Tana Lake, 225
- Tar, 180
- Tarnau, 12
- Tarsus, 211
- Tartu, 290
- Tashkent, 12, 151, 152
- Tasmania, 282, 417, 418, 419
- Tataria, 313
- Tedzhen, Oasis, 154
- Teheran, 152
- Temuco, 401, 404, 405
- Tennessee, 366, 368
- Tern.ez, 162
- Texas, 373, 374, 377
- Thessaly, 48, 59, 91, 210, 231, 268, 270
- Thuringia, 92, 270, 274
- Tibet, 50, 90, 91, 172, 177, 242
- Tiflis, 129
- Tianshan, 90, 177, 179, 180, 344
- Tientsin, 244
- Tigris, 97
- Tihama, 191
- Tikhoretsk, 309
- Tiraspol, 317
- Tisza, 300
- Titicaca, 391, 392, 406
- Tlemcen, 216, 217
- Tobolsk, 336
- Tokyo, 254
- Toronto, 360
- Toulouse, 264
- Trabzon, 113, 114
- Trans-Alai Range, 90, 174, 175
- Trans-Baikal Area, 92, 340, 343, 347
- Transcaspian, Area, 119
- Transcaucasus, 8, 15, 76, 79, 87, 88, 115, 119, 120, 122, 128, 142
- Transjordan, 8, 17, 94, 98, 100, 112
- Transvaal, 422, 423, 426, 427
- Trans-Volga Area, 54
- Trikkala, 271
- Trinidad, 6
- Tripolis, 271
- Tsingtao, 244
- Tsingling Shan, 91
- Tsitsitsin-gol, 253
- Tsetserlig, 256
- Tucuman, 399, 410
- Tula Area, 118
- Tulun, 341, 343
- Tunis, 54, 69, 72, 207, 211, 234, 235, 352
- Turin, 267
- Turkestan, 90, 147, 178, 180
- Turkestan, Chinese, 57, 66
- Turkestan, Province, 151

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

- Turkestan, Range, 96, 174, 175 USSR-in-Asia, 178
- Turkey, 23, 85, 91, 97, 110, 115, 132, 268, 269, 426 Ussuri, 349
- Turkmenia, 50, 151, 152, 157, 162 Ust-Tsilma, 352
- Turkmenistan, 90 Utah, 369, 371
- Tuva Autonomous Region, 252 Utrecht, 295, 296
- Tyrol, 94, 273, 276 Uzbekistan, 90, 147, 151, 157, 162, 164, 165, 178
- UCH-KULAN, 120, 147 VALDIVIA, 401, 404
- Uch-Turfan, 90, 147, 167, 168, 171, 274 Valencia, 61, 207, 399, 401, 408
- Udmurt, ASSR, 327 Valladolid, 260, 263
- Ukraine, 6, 38, 94, 102, 134, 299, 300, 302, 304 - 306, 308, 367 Valparaiso, 404, 405
- Ukraine, Western, 5 Van, 136
- Ulan-Bator, 252, 253, 256 Vancha, 155, 156, 159
- Ulan Udeh, 340, 343, 345 Vardar, 91, 268
- Uliassutaï, 256 Vatra-Dornei, 278
- Union of South Africa, 422, 426 Velikie Luki, 325
- United Provinces, 187, 188 Velikie Luki Region, 323
- Uppsala, 298 Verkhoyansk, 344, 348
- Ural, 299, 313, 321, 327, 332 Vermilion, 357
- Uruguaiana, 403 Victoria, 408, 410, 414, 417, 418, 421
- Uruguay, 87, 93, 382, 385, 388, 394, 399 Vilyuy, 344
- Urukh Canyon, 147 Vilnyus, 290
- Urumchi, 167 Vinnitsa, 318
- USA, 6, 11, 12, 38, 53, 58, 72, 87, 93, 306, 354, 355, 361, 364 - 367, 369 - 374, 377 - 379, 382, 388, 425, 426 Virginia, 374, 379
- Uskiup, 269 Vladivostok, 349 - 351
- USSR, 5, 11, 12, 41, 85, 144, 277, 357 Volga, Area, 6, 38, 56, 92, 300, 308, 310, 311
- Vologda Region, 323, 327
- Voronezh, 320
- Voronezh Region, 47, 308, 311, 312, 313 - 320

WARSAW, 322

ZAGREB, 301

Washington, D. C., 378

Zaisan, 338

Washington, State, 369, 371 - 373

Zakataly Area, 89, 134, 135

Wei-Ho, 91, 241

Zangezur, 136

Wellington, 422

Zebak, 173

Winnipeg, 357, 362

Zeia, 344

Wisconsin, 369, 370

Zhitomir, 317

Wroclaw, 288

Zima, 341

Wurttemberg, 92, 270, 274, 285,
286

Zurich, 273, 276

Wuerzburg, 278

Zuvand, 90, 121, 144

Wyoming, 369, 372

YAKUTIA, 93, 344, 348, 349

Yakutsk, 348

Yalgoo, 421

Yangigisar, 66

Yangtse, 91, 242

Yarkand, 66, 90, 147, 167, 168

Yaroslavl, Region, 323

Yellow River, 235

Yemen, 55, 90, 191

York, 277, 297

Yucatan, 6, 375, 376

Yugoslavia, 91, 270, 299 - 301

Yungas, 397

Yunnan-Fu, 91, 246

LIST OF ILLUSTRATIONS

Figures

- Fig. 1 Timofeev wheat—Triticum timopheevi Zhuk. Transcaucasus (p 11)
- Fig. 2 Persian wheat—Triticum persicum Vav. ("Wild"), Georgian SSR (p 11)
- Fig. 3 Persian wheat—Triticum persicum Vav. Daghestan ASSR (p 12)
- Fig. 4 Avena byzantina C. Koch—Typical form of Mediterranean oats, Algiers (p 12)
- Fig. 5 Soft wheat - Triticum vulgare Vill., Kakhetin Banatka variety (p 15)
- Fig. 6 Flax - Linum usitatissimum L., creeping form, Abkhaza ASSR (p 16)
- Fig. 7 Barley—Hordeum vulgare L. var. Dundarbeyi Zhuk. (of Japanese origin), Cilicia (p 20)
- Fig. 8 Flax - Linum usitatissimum L., Pskov, long-flax (p 22)
- Fig. 9 Flax - Linum usitatissimum L., dwarf, moderate speed of maturation, Ethiopia (p 22)
- Fig. 10 Hard wheat—Triticum durum Desf., Ethiopia, Gondar area (p 23)
- Fig. 11 Hard wheat—Triticum durum Desf., Ethiopia, Harrar area (p 23)
- Fig. 12 Soft wheat - Triticum vulgare Vill., China (p 24)
- Fig. 13 Soft wheat—Triticum vulgare Vill., N. China (p 27)
- Fig. 14 Spelt wheat - Triticum spelta L., Spain (p 47)
- Fig. 15 Club wheat - Triticum compactum Host., Afghanistan (p 48)
- Fig. 16 Club wheat - Triticum compactum Host., Sunpan (p 48)
- Fig. 17 Chinese club wheat - Triticum compactum Host., China (p 49)
- Fig. 18 Round grain wheat - Triticum sphaerococcum Perc. (p 50)
- Fig. 19 Round grain wheat - Triticum sphaerococcum Perc., Punjab variety (p 50)
- Fig. 20 Yemen two-grained wheat—Triticum diococcum Schubl. Yemen (p 51)
- Fig. 21 Cultivated two-grained wheat (spelt)—Triticum diococcum Schubl. Volga area (p 52)
- Fig. 22 Cultivated two-grained wheat (spelt)—Triticum diococcum Schubl. Ethiopia (p 52)
- Fig. 23 Avena sativa L. —Field weed oats from field sown with spelt. Georgian SSR, Skhuchalak area (p 53)
- Fig. 24 Avena sativa L. Field weed oats from field sown with spelt. Georgian SSR, Gori area (p 54)
- Fig. 25 Sown peas—Pisum sativum L., Afghanistan (p 58)
- Fig. 26 Lentils—Lens esculenta Moench var. afghanica Bar. Afghanistan (p 59)
- Fig. 27 Lentils—Lens esculenta Moench var. indica Al. India (p 60)

- Fig. 28 Chick pea—Cicer arietinum L., India (p 61)
- Fig. 29 Curly flax—Linum usitatissimum L., with crinkly petals (in the ovals),
China, Kashgar, Yangigesar (p 62)
- Fig. 30 Curly flax—Linum usitatissimum L., white-colored, late-maturing, Khiva
(p 63)
- Fig. 31 Rye—Secale cereale L. Details of the ligulated form. Pamir (p 63)
- Fig. 32 Rye—Secale cereale L. Details of the ligulated form, as in sedges (p 63)
- Fig. 33 Macha wheat—Triticum macha Del, et Men. Georgian SSR (p 64)
- Fig. 34 Avena brevis Roth, var. turgida, Vav.—Short oats in fields sown with
wheat Triticum turgidum L., Portugal (p 67)
- Fig. 35 Cultivated one-grained wheat—Triticum monococcum L., Germany (p 98)
- Fig. 36 Wild-growing and high peas, Pisum elatius (M.B.) Stev. Palestine (p 98)
- Fig. 37 Red-yellow wild-growing peas—Pisum fulvum Sibth. and Sm. Palestine
(p 99)
- Fig. 37a Red-yellow wild pea—Pisum fulvum Sibth et Sm. Palestine (opp 99)
- Fig. 38 Sow pea—Pisum sativum L. Syria (opp 99)
- Fig. 38a Sown peas—Pisum sativum L. Syria (p 99)
- Fig. 39 Lentils—Lens esculenta Moench, var. syriaca Bar. Syria (p 100)
- Fig. 40 Chick pea—Cicer arietinum L., Palestine (p 101)
- Fig. 41 Wild-growing barley—Hordeum spontaneum C. Koch, Syria (p 102)
- Fig. 42 Soft wheat—Triticum vulgare Vill, Syria (p 102)
- Fig. 43 Soft wheat—Triticum vulgare Vill., Mesopotamia (p 102)
- Fig. 44 Barley—Hordeum distichon L. var. syriacum Vav. and Orlov, Syria (p 103)
- Fig. 45 Barley—Hordeum vulgare L., var pallidum Ser. Palestine (p 103)
- Fig. 46 Cultivated one-grained wheat einkorn—Triticum monococcum L., Turkey
(p 108)
- Fig. 47 Soft wheat—Triticum vulgare Vill., xerophyl form, Turkey (p 108)
- Fig. 48 Georgian wheat—Triticum georgicum Dek., Georgian SSR (p 109)
- Fig. 49 Flax—Linum usitatissimum L., Creeping form, Abkhazian SSR (p 109)
- Fig. 50 Lentils—Lens esculenta Moench. Var. subnummularia Bar. Turkey.
Denizli (p 110)
- Fig. 51 Wild two-grained wheat (spelt)—Triticum dicoccoides Korn, Armenian SSR
(p 111)
- Fig. 52 Wild-growing barley—Hordeum spontaneum Koch, Trans-Caspian region
(p 111)
- Fig. 53 Field weed rye—Secale cereale L., Brittle black-ear form, Transcaucasus
(p 112)
- Fig. 54 Field weed rye—Secale cereale L., Brittle white-ear form, Transcaucasus
(p 112)
- Fig. 55 Field weed rye—Secale cereale L., Semi-brittle form, Transcaucasus
(p 115)
- Fig. 56 Field weed rye—Secale cereale L., Azerbaijan SSR (p 115)

- Fig. 57 Soft wheat—Triticum vulgare Vil. Dolis-Puri variety, Georgian SSR (p 117)
- Fig. 58 Hard wheat—Triticum durum Desf., Semi-winter, Azerbaijan SSR (p 120)
- Fig. 59 Naked grain barley—Hordeum distichon, L., var. daghestanicum, Vav. et
Orl. Daghestan ASSR (p 122)
- Fig. 60 English wheat—Triticum turgidum L., Kakhetia (p 122)
- Fig. 61 Soft wheat Triticum vulgare L., local variety. Rach'ul (Khuluga),
Georgian SSR (p 123)
- Fig. 62 Barley—Hordeum distichon L., var. nutans, Schubl., subvar. colchicum,
Reg. Transcaucasia (p 123)
- Fig. 63 Sow pea—Pisum sativum L. Georgian SSR, Bakuriani (opp 123)
- Fig. 64 Asiatic subspecies of beans—Vicia faba L., ssp. pauciluga f. daghestanica
Murat, Daghestan ASSR, Beans 3:4; seeds 5:3 (p 127)
- Fig. 65 Hard wheat—Triticum durum Desf. ("Tavtukhi"), Georgian SSR (p 128)
- Fig. 66 Soft wheat—Triticum vulgare Vill., Arditto variety, Italy (p 130)
- Fig. 67 Soft wheat—Triticum vulgare Vill., Armenian SSR (p 133)
- Fig. 68 Barley—Hordeum distichon L., var. nutans Schubl., Armenian SSR (p 133)
- Fig. 69 Chick pea—Cicer arietinum L., Armenian SSR (p 134)
- Fig. 70 Hard wheat—Triticum durum, Desf. Daghestan SSR (p 135)
- Fig. 71 Field weed rye—Secale cereale. Long-eared form, Pamir. (p 145)
- Fig. 72 Soft wheat—Triticum vulgare Vill. Afghanistan, area of Harat (p 147)
- Fig. 73 Soft wheat—Triticum vulgare Vill. Afghanistan, Khezari Road (p 147)
- Fig. 74 Soft wheat—Triticum vulgare Vill. Afghanistan, upper reaches of Kabul
River (p 150)
- Fig. 75 Soft wheat—Triticum vulgare Vill., rigid form; Central Asia (p 150)
- Fig. 76 Soft wheat—Triticum vulgare Vill., Bukhara (p 151)
- Fig. 77 Wild grain barley—Hordeum spontaneum C. Koch, ear and its parts,
Central Asia (p 151)
- Fig. 78 Barley—Hordeum distichon, L. nutans, Schubl Afghanistan (p 151)
- Fig. 79 Field weed rye—Secale cereale L., Brittle and semi-brittle forms,
Afghanistan (p 154)
- Fig. 80 Field weed rye—Secale cereale L., Non-brittle forms, Afghanistan (p 154)
- Fig. 81 Sown peas—Pisum sativum L., Iran (p 154)
- Fig. 82 Chick pea—Cicer arietinum L., Uzbek SSR (p 156)
- Fig. 83 Chick pea—Cicer arietinum L., Iran (p 156)
- Fig. 84 Cultivated grass pea (chickling vetch)—Lathyrus sativus L., Uzbek SSR
(p 157)
- Fig. 85 Flax—Linum usitatissimum L., Afghanistan (p 158)
- Fig. 86 Flax—Linum usitatissimum L., Afghanistan, Shibirghan (p 158)
- Fig. 87 Flax—Linum usitatissimum L., Late, high, China, Sinkiang (p 160)
- Fig. 88 Naked-grain barley—Hordeum vulgare L., var. coeleste L., Pamir (p 164)
- Fig. 89 Flax—Linum usitatissimum L., low height, mountainous Badakhshan
Maimana (p 165)

- Fig. 90 Flax—Linum usitatissimum L., Mountainous Badakhshan Region of the Tadzhik SSR (p 166)
- Fig. 91 Hard wheat—Triticum durum Desf. India (p 170)
- Fig. 92 Soft wheat—Triticum vulgare Vill., Kashmir (p 175)
- Fig. 93 Flax—Linum usitatissimum—Small seed dwarf; India (175)
- Fig. 94 Flax—Linum usitatissimum L., Large seed, India (p 176)
- Fig. 95 Abyssinian peas—Pisum abyssinicum Braun. Yemen (p 185)
- Fig. 96 English wheat—Triticum turgidum L., ssp. abyssinicum Vav., rare form with flat-ear scales. Ethiopia (p 185)
- Fig. 97 English wheat—Triticum turgidum L., ssp. abyssinicum Vav., Ethiopia, area of Adis Ababa (p 185)
- Fig. 98 English wheat—Triticum turgidum L., ssp. abyssinicum Vav., loose-ear form, Ethiopia, area of Adis Ababa (p 188)
- Fig. 99 English wheat—Triticum turgidum L., ssp. abyssinicum Vav., Ethiopia, area of Adis Ababa (p 188)
- Fig. 100 English wheat—Triticum turgidum L., ssp. abyssinicum Vav., Ethiopia, area of Gondar (p 188)
- Fig. 101 Common wheat—Triticum vulgare Vill., Ethiopia (p 191)
- Fig. 102 Barley—Hordeum vulgare L., Vav., pallidum Ser., Ethiopia (p 192)
- Fig. 103 Barley—Hordeum vulgare L., var. nigripallidum Reg., Ethiopia (p 192)
- Fig. 104 Barley—Hordeum distichon L., var. abyssinicum Ser., Ethiopia (p 193)
- Fig. 105 Barley—Hordeum distichon L., var. deficiens Steud., Ethiopia (p 193)
- Fig. 106 Barley—Hordeum distichon L., var. zeocrithideficiens Vav. Ethiopia (p 194)
- Fig. 107 Barley—Hordeum vulgare L., var. eurylepis Korn, Ethiopia (p 195)
- Fig. 108 Abyssinian oats—Avena abyssinica Hochst. Weed in barley, Ethiopia, Harrar area (p 196)
- Fig. 109 Sow pea—Pisum sativum L., Ethiopia (opp 196)
- Fig. 110 Flax—Linum usitatissimum L., Farley, Ethiopia (p 198)
- Fig. 110a Lentils—Lens esculenta L., var. abyssinica (Hochst) Al., Ethiopia (p 197)
- Fig. 111 Chick peas—Cicer arietinum L., Ethiopia (p 198)
- Fig. 112 English wheat—Triticum turgidum L., Mediterranean form (p 204)
- Fig. 113 Hard wheat—Triticum durum Desf. Egypt (p 204)
- Fig. 114 Durum wheat—Triticum durum Desf., Algeria (p 207)
- Fig. 115 Polish wheat—Triticum polonicum L., Morocco (p 207)
- Fig. 116 Soft wheat—Triticum vulgare Vill. Alpine type, Italy (p 208)
- Fig. 117 Sown peas—Pisum sativum L., Egypt (p 208)
- Fig. 118 Sow pea—Pisum sativum L., Morocco (opp 123)
- Fig. 119 Variability of height of branches, stem and size of leaves in relation to evolution of species vicia faba, L. (p 209)
- Fig. 120 Mediterranean sub-species of beans—Vicia faba L. ssp. maxima f. macrosperma (Alef). Murat. Island of Cyprus. Beans natural size seed X 2 (p 210)

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

- Fig. 121 Plate-like lentil—Lens esculenta Moench. ssp. macrosperma (Baumg). Bar. var. nummularia Al. Italy. Plant, bean X 2, seeds X 4 (p 210)
- Fig. 122 Flax—Linum usitatissimum L., Large seed, Morocco (p 211)
- Fig. 123 Flax—Linum usitatissimum L., Algeria (p 211)
- Fig. 124 Flax—Linum usitatissimum L., large fruit, large seed, Egypt (p 215)
- Fig. 125 Flax—Linum usitatissimum L., Italy (p 215)
- Fig. 126 English wheat—Triticum turgidum L., China (p 228)
- Fig. 127 Barley—Hordeum vulgare L., var. breviaristatum Vav. China (p 228)
- Fig. 128 Barley—Hordeum vulgare L., var. nigritonsum Korn, China (p 231)
- Fig. 129 Barley—Hordeum vulgare L., var. subpyramidatum Orl., Japan (p 231)
- Fig. 130 Barley—Hordeum vulgare L., var. brachyatherum Korn, China (p 231)
- Fig. 131 Barley, naked-grain—Hordeum vulgare L., var. coeleste L., Mongolia (p 244)
- Fig. 132 Barley, naked-grain—Hordeum vulgare L., var. trifircatum, Mongolia (p 246)
- Fig. 133 Oats, naked-grain—Avenum sativa L., var. nuda. China, Inner Mongolia (p 246)
- Fig. 134 Oats, sandy—Avena strigosa Schreb., weed in fields sown with cereals, Portugal (p 249)
- Fig. 135 Chick pea—Cicer arietinum L., Spain (p 249)
- Fig. 136 Grass pea—Lathyrus sativus, L., Spain (p 249)
- Fig. 137 Soft wheat—Triticum vulgare Vill., var. Villmoran 27, France (p 253)
- Fig. 138 Barley—Hordeum distichon L., var. nutans, Schubl. Hanna Loosdorf variety (p 253)
- Fig. 139 Soft wheat—Triticum vulgare Vill., Robusta var. Holland (p 262)
- Fig. 140 Sown oats—Avena sativa L., thick fruit form. Western Europe (p 262)
- Fig. 141 European subspecies of beans—Vicia faba ssp. europaea f. viridissima (Alef Murat. Windsor beans. England. Beans, natural size, seeds X 2 (p 278)
- Fig. 142 Sown peas—Pisum sativum L., England (p 278)
- Fig. 143 Pod and seeds of the Victoria Mandorf variety of peas (p 278)
- Fig. 144 Pod and seeds of the Capital pea widespread in cultivated areas of the USSR (p 278)
- Fig. 145 Cultivated rye—Secale cereal L., Petcus variety (p 286)
- Fig. 146 Soft wheat—Triticum vulgare Vill., Zarya variety (p 286)
- Fig. 147 Soft wheat—Triticum vulgare Vill., Triumph of Podolia variety (p 290)
- Fig. 148 Hordeum vulgare L. var. pallidum Ser., pallidum variety 045 (p 290)
- Fig. 149 Cultivated rye—Secale cereale L., Elyseev variety (p 297)
- Fig. 150 Cultivated rye—Secale cereale L., Verzhbin variety, Poland (p 297)
- Fig. 151 Cultivated rye—Secale cereale L., Vyatka variety (p 297)
- Fig. 152 Sown oats—Avena sativa L., Leitevits variety (p 297)
- Fig. 153 Sown oats—Avena sativa L., Stepnyak variety (p 300)

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

- Fig. 154 Sown peas—Pisum sativum L., Voronezh region (p 302)
- Fig. 155 Flax—Linum usitatissimum L., intermediate fiber flax, Voronezh region (p 302)
- Fig. 156 Barley—Hordeum vulgare L., var. pallidum, Ser. Archangel'sk region (p 307)
- Fig. 157 Barley—Hordeum vulgare L., var. erectum 865/3. Pushkin Experimental Station of the All-Union Institute of Plant Breeding (p 307)
- Fig. 158 Flax—Linum usitatissimum L., type of low long-fiber flax, Archangel'sk region (p 308)
- Fig. 159 Variety of pea Zhegalova, G-112 type, on the lands of the All-Union Institute of Plant Breeding, Moscow Region (p 309)
- Fig. 160 Northern subspecies of beans Vicia faba L., ssp. septentrionalis f. janthina Murat., Black Russian beans, Pods natural size, seeds X 2 (p 309)
- Fig. 161 Lentil—small seed and fodder—Lens esculenta Moench ssp. microsperma (Baumg.) Bar. var. vulgaris (Al.) Bar. from Molotov region (p 311)
- Fig. 162 Sown oats—Avena sativa L., Tulon 86/5 variety, Eastern Siberia (p 321)
- Fig. 163 Cultivated rye—Secale cereale L., spring form Yaritsa, Eastern Siberia (p 321)
- Fig. 164 Hybrid of club wheat—Triticum compactum host. Henkins, USA (p 327)
- Fig. 165 Sown oats—Avena sativa L., Markton variety; highly resistant to loose and stinking smut; USA (p 327)
- Fig. 166 Common wheat—Triticum vulgare Vill., Variety 38-MA, Argentina (p 371)
- Fig. 167 Soft wheat—Triticum vulgare, Nabawa variety, Australia (p 387)

Photographs

- N. I. Vavilov, Portrait by the artist Strebllov (p 6)
- Syria, the Hauran. Rocky locality (basalt stones). Triticum dicoccoides is found in large quantities (p 9)
- Syria, Beshri. Cedars of Lebanon (p 9)
- Syria. Threshing boards made out of stones in the Hauran (p 10)
- Syria, the Hauran. Grain depot near a railway station (p 10)
- Transjordan. The Es-Salt area, where Triticum dicoccoides is found (p 13)
- Terrace cultivation in Druze villages of Northern Palestine (p 13)
- Palestine, Safed. Home of Triticum dicoccoides (p 14)
- Academician N. I. Vavilov's Caucasus expedition. Departure from Sukhumi on the road to Pitsunda (Gagerek District of the Abkhaz SSR). In the car Academician N. I. Vavilov, An. A. Fedorov, V. F. Nikolaev, and the driver A. I. Baikov (Photo D. Rakitin) (p 14)
- Caucasus. Academician N. I. Vavilov's expedition in Svanetiyu. Resting in a shepherd's hut (Photo D'yakova) (p 17)
- Caucasian expedition of the Academy of Sciences of the USSR in 1939. Picking wheat in Northern Osetia (village of Digori) (p 17)
- Caucasus. Valley in Southern Osetia (Photo D'yakova) (p 18)
- Iran. Agriculture on rocky soil in a valley (p 18)
- Iran. Cultivation of stony soil with local implements (p 25)
- Iran. Threshing of wheat by horses (p 25)
- Iran. Peasant family near their meager wheat harvest (p 26)
- Iran. Wheat threshing (p 26)
- Iran. On the Hamadan road (p 29)
- Kazakh SSR. Academician N. I. Vavilov's expedition to Kara-Tau in search of Tau-saghyz [Scorzonera tausaghyz, the black palsify], 1933-1934, Tau-saghyz found. At left, N. I. Vavilov (p 29)
- China, Sinkiang. The Irkeshtam-Kashgar Road. The expedition caravan (p 30)
- China, Sinkiang. The Irkeshtam-Kashgar Road. Transportation of cotton from Kashgar to the USSR (p 30)
- China, Sinkiang. Wheat stack near a Taranchi tribe village. Photograph, V. A. Dubyanskii (p 35)
- Afghanistan. Tadjik mountain villages at the foot of the Saleng Pass, at an altitude of 2,450-2,700 m above sea level (southern slope of the Hindu-Kush) (p 35)
- Afghanistan. Peasant with plough near Kabul (p 36)
- Afghanistan. Wild watermelons in the Bak desert (p 36)

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX
Afghanistan, northern slope of the Hindu-Kush. Sorting wheat in the Kishlak
of Modor (p 39)

Ethiopia, Harrar area. Stack of durra (p 39)

Ethiopia. Tilling a field near Gondar (p 40)

Ethiopia, Addis Ababa. Bazaar, sale of sugar cane (p 40)

Egypt. On the edge of the desert (p 43)

Threshing wheat in Lower Egypt (p 43)

Egypt. Traveller resting in the desert (p 44)

Greece, Thessaly. Harvesting crops (p 44)

Greece, Thessaly. Harvest of English wheat (p 55)

Island of Cyprus. A bazaar in the town of Nicosia (p 55)

Island of Sicily, harvesting of horse beans (p 56)

Algeria. Threshing wheat by running work animals over the grain
(near Setif) (p 56)

Vegetable and fruit market in Tunis (p 65)

Japan. Usual method of drying corn on the cob on the island of Hokkaido (p 65)

Japan. Threshing of adzuki beans [*Phaseolus angularis*] on the island of
Hokkaido. Typical jointed bamboo flails (p 66)

Japan. Well tended fields of rice near Hakodate (p 66)

Japan. Island of Hokkaido, the most perfected method of drying rice on
wooden poles (p 69)

Japan. Drying wreaths of rice on the island of Hokkaido. The man in the
harvested field is N. I. Vavilov (p 69)

Japan. Island of Hokkaido. Assembling stacks of rice on wooden tripods (p 70)

Japan. Shizuoka. Tea plantation (p 70)

Japan. Harvesting long white radish on the island of Hokkaido (p 73)

Japan. Harvesting of another variety of long white radish on the island of
Hokkaido (p 73)

Brazil. Hand cultivation of rice clusters in the State of Sao Paulo (p 74)

Brazil. Transportation of sugar cane (p 74)

Peru. Peasant woman from Cusco Province (p 78)

Brazil. Coffee plantations in Sao Paulo State (p 78)

Peru. Inhabitants of one of the towns (p 79)

Brazil. Coffee plantations in Sao Paulo State (p 79)

Syria. Environs of Damascus (p 91)

Syria. Bazaar in Homs (p 91)

Syria. Villages in the Hauran, on the Palestine border (p 92)

Syria. Peasant Arabs in village near Euphrates River (p 92)

Palestine. Solomon's Pools (p 95)

Palestine. Nomad Arabs near Hebron (p 95)

Palestine, Transjordan, Jerash (p 96)

Palestine. Primitive mills found in the digs at Jerash (Transjordan) (p 96)

Northern Palestine. Arab village (p 106)

Northwestern Palestine. Fixing the dunes (p 106)

Nomads in Transjordan (p 107)

Palestine. Oasis of Khan Yunis (p 107)

Caucasian expedition of the USSR Academy of Sciences (1939) into Northern Osetia Village of Styr-Digori (p 113)

On the Kuban Experimental Station of the All Union Institute of Plant Breeding (1926). Seated Academician N. I. Vavilov, at left, Director of Station, A. I. Orlov (p 113)

Caucasian Expedition of the USSR Academy of Sciences, 1939, into Northern Osetia. Road to village of Styr-Digori (p 114)

Krasnodar territory, the foothill zone of the Northern Caucasus (Tula area), village of Shuntuki. Photograph by P. P. Gusev (p 114)

Fields of the Sukumi Experimental Station sown with corn from Central Mexico. At left M. I. Khadzhinov. At right I. V. Kozhukov (p 118)

Giants from the collection of Mexican French beans at the Sukumi Experimental Station (p 118)

Maikop Experimental Station (1934). Academician N. I. Vavilov inspecting portion of plum plantations. Photograph by E. P. Gusev (p 119)

Maikop Experimental Station. Blossoming of wild pear (p 119)

Iran. Valley landscape (p 143)

Tadzhik SSR. Valley of the Sur Khab River on the Garm Novobad road. Photograph by A. S. Tuz (p 143)

Valley of Shakhimardan, Alai Range. Photograph by Fergana Expedition (p 144)

Mountain gardens of the village of Bogustan along the Iskem River in the Talas Ala tu, 1,100 meters above sea level. Photograph by N. V. Kovalev (p 144)

Tadzhik SSR. Wood of walnut in the Vanch River valley. Photograph by A. V. Gurskii (p 148)

Upper reaches of Ispaisai, 1,700 meters above sea level. Upper limit of wood vegetation. Photograph by N. V. Kovalev (p 148)

Tadzhik SSR. Nut-pear forest in the Vanch River valley. Photograph by A. V. Gurskii (p 149)

Tadzhik SSR. Kishlak of Kuf in the Rushan area. Sheaves of pressed wheat. Photograph by A. V. Gurskii (p 149)

Tadzhik SSR. Ancient river terraces on the right bank of the Gunt River, at junction with Shakhdara River. On terraces are fields, gardens and villages. Photograph by A. V. Gurskii (p 152)

Tadzhik SSR. Remains of nut forests in the Vanch River valley. In the distance are canals bringing water from the mountains. Photograph by A. V. Gurskii (p 152)

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX

Tadzhik SSR. Method of packing hay on roofs of animal buildings in mountain areas. Photograph by A. V. Gurskii (p 153)

Tadzhik SSR. Apricot tree among fields of wheat in the valley of the River Gunt. Photograph by A. V. Gurskii (p 153)

Kashgar. Bullocks harnessed to local implement for cultivating fields (p 161)

Kashgar. Vegetable bazaar (p 161)

Afghanistan. Types of inhabitants (p 162)

Afghanistan. Family of nomadic Maldars near the Bakvi desert along the Kosh-Dari River (not far from Sultan Bakv) (p 162)

Ethiopia. Sega Vadem. Tributary of the Blue Nile (p 183)

Blue Nile (near Abbai) (p 183)

Central Ethiopia, near Fich, inhabitants of villages (p 184)

Eastern Ethiopia, Harrar. Thickets of Acacia and woodlike spurge (*Euphorbia abyssinica*) (p 184)

Ethiopia. Woman peasant near Addis Ababa (p 189)

Ethiopia. Harrar. Galas peasants (p 189)

Eritrea. Baobab (p 190)

Ethiopia. Water collecting installations (p 190)

Egypt. Threshing grain in the desert (p 202)

Egypt. Transportation of wheat on camels in Giza (p 202)

Village in Lower Egypt (p 203)

Egypt. Ruins of Karnek. Ancient pictures (p 203)

Egypt. Harvesting of wheat (p 213)

Egypt. Melons and bananas at the Gura well (p 213)

Egypt. Native types of Belakhsia (p 214)

Egypt. Luxor. Irrigation of cotton (p 214)

Egypt. Giza. Landscape in the desert (p 216)

Egypt. Oasis in the desert (p 216)

Egypt. Hult in the desert (p 217)

Egypt. Deserts of the Sahara, on the road (p 217)

Village in the southern part of the island of Crete (p 220)

Greece. Peasants in Thessaly (p 220)

Western Cyprus. Ploughing with mules (p 221)

Sicily. Village near Katania (p 221)

Algeria. Villagers on the threshing floor (village near Setif) (p 222)

Algeria. Improved plough, near Sidi bel Abbes (p 222)

Inhabitants of Central Tunisia (p 223)

Inhabitants of mountainous Tunisia (p 223)

Morocco, Marrakesh (p 226)

Morocco. Irrigation system, near Marrakesh (p 226)

Primitive villages of Southern Morocco (p 227)

Morocco. Villages and native types near Kasbah Tadleh (p 227)

Japan. Typical village house on the island of Hokkaido (p 238)

Japan. Village children on the island of Hokkaido (p 238)

Japan. Type of village houses on the island of Hokkaido. Roof of rice straw (p 239)

Japan. Harvesting radish on the island of Hokkaido (p 239)

Germany. Wue-rttemberg. Spelt (p 272)

Germany. Wuerttemberg. Harvesting of true spelt (p 272)

Germany. Harvesting hybrids of true spelt with wheat (p 273)

Germany. Harvesting hybrids of true spelt with wheat (p 273)

Mexico. Yucatan, near Merifa. A Mai peasant with a tool for cutting plants (p 349)

Mexico. Yucatan. Stone grinders preserved in villages near Chichen Itza (p 349)

Mexico, Yucatan. Typical habitation near Chichen Itza (p 350)

Argentina, Santa Cruz. Flock of sheep (p 350)

Argentina, Buenos Aires Province. Fattening cattle on natural pastures (p 355)

Argentina. Llama (guanaco) (p 355)

Argentina. Cactuses in Andargala (province of Katamarkh) (p 356)

Argentina. Harvesting of wheat by combine on the Prairie Experimental Station (p 356)

Argentina. Perennial plantation of Paraguayan tea (mate) (p 357)

Uruguay. Salix Humboldtiana in Montevideo park (357)

Brazil. Spinning liana in tropical forest near Amazon River (p 358)

Brazil. Coffee depot (p 358)

Brazil. Typical habitations of poor peasants of the Amazon area (p 361)

Southern Brazil. Tilling cotton fields after clearing away tropical forest (p 361)

Brazil. At the Bazaar in Belem (Para), Cucurbita moshata and bananas (p 362)

Bolivia. Snow cap of Illimani mountain, 6447 meters above sea level. In foreground are eucalyptus (p 362)

Bolivia. Indian with llama (p 363)

Bolivia. Sorting potatoes (p 363)

Bolivia. Preparation of chuno in progress (p 364)

Bolivia. Preparing chuno from potatoes (p 364)

Bolivia. Construction of reed boats on Lake Titicaca (p 366)

Bolivia. On Lake Titicaca (p 366)

Bolivia. Near Lake Titicaca (p 367)

Bolivia. On Lake Titicaca (p 367)

Bolivia. Province of Yungas. Quinine tree (Cinchona) (p 368)

Peru. Primitive agricultural implements of inhabitants of Hualato, Peru (p 368)

Peru. Indian hut, Choza (p 369)

Peru. Llamas in environs of town of Kusco (p 369)

WORLD RESOURCES OF CEREALS, LEGUMINOUS SEED CROPS AND FLAX
Australia. Reclaiming hills of valley under perennial plantations of citrus and
other crops (p 382)

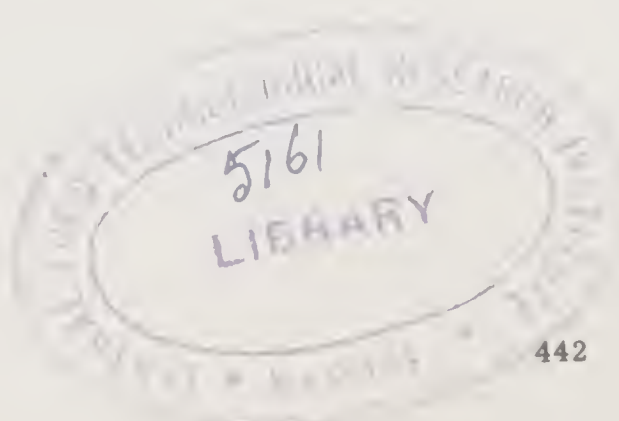
Australia. Eucalyptus (p 382)

Australia. View of valley with cultivated areas (p 383)

Australia. Citrus plantations (p 383)

Maps

- Map 1. Agricultural areas of the USSR as of 1935 (cultivated area without fallow land, including gardens and vineyards) (p 83)
- Map 2. World areas sown with wheat, rye, oats, barley, peas, lentils, chick peas, beans, grass-peas, vetch, and flax, as of 1935-1936 (p 84)
- Map 3. Hindustan and adjoining areas. Areas under cultivation as of 1936 (cultivated area without fallow land but including gardens and vineyards). Each dot corresponds to 250,000 hectares. Compiled by I. F. Makarov and I. V. Chekan. Edited by Acad. N. I. Vavilov (p 173)
- Map 4. Indo China and Indonesia. Agricultural areas as of 1936. (Cultivated non-fallow areas, including gardens and vineyards). Each dot corresponds to 250,000 hectares. Compiled by I. F. Makarov and I. V. Chekan. Edited by Academician N. I. Vavilov (p 178)
- Map 5. Southeastern Asia. Agricultural areas as of 1936. (Cultivated non-fallow areas including gardens and vineyards). Each dot corresponds to 250,000 hectares. Compiled by I. F. Makarov and I. V. Chekan. Edited by Academician N. I. Vavilov (p 225)
- Map 6. North and Central America. Agricultural areas as of 1936 (cultivated and fallow areas, including gardens and vineyards). Each dot represents 250,000 hectares; x represents 16,000 hectares. Compiled by I. F. Makarov and I. V. Chekan. Editor: Acad. N. I. Vavilov (p 332)
- Map 7. South America. Agricultural areas as of 1936. (Cultivated and fallow area, including gardens and vineyards). Each dot represents 250,000 hectares. Compiled by I. F. Makarov and I. V. Chekan; Edited by Acad. N. I. Vavilov (p 359)
- Map 8. Australia. Agricultural areas as of 1936. (Cultivated non-fallow area, including gardens and vineyards). Each dot represents 250,000 hectares. Each x represents 50,000 hectares. Compiled by I. F. Makarov and I. V. Chekan; Edited by Acad. N. I. Vavilov (p 371)
- Map 9. Africa. Agricultural areas as of 1936. (Cultivated non fallow-area including gardens and vineyards). Each dot represents 250,000 hectares and each x represents 10,000 hectares. Compiled by I. F. Makarov and I. V. Chekan. Edited by Acad. N. I. Vavilov (p 397)





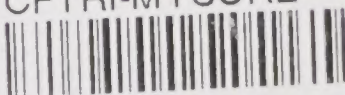
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World resources...

